JUL 17 1944

JULY, 1944 — 7th ANNUAL AIRCRAFT PRODUCTION NUMBER

MACHINERY

ELGIN PRECISION HAND SCREW MACHINE

WATCH-LIKE ACCURACY

VARIABLE SPEED DRIVE
120 TO 3800 RPM

New Horizons

After Victory, industrial requirements will find Elgin Precision Machines ready for the higher standards of the future. The name Elgin has gained an enviable reputation for precision — especially in the instrument and optical field.

ELGIN *Precision Machines* SINCE 1901

ELGIN TOOL WORKS, CHICAGO

Meet Specific requirements of every job

ON VERSATILE HEALD BORE-MATICS

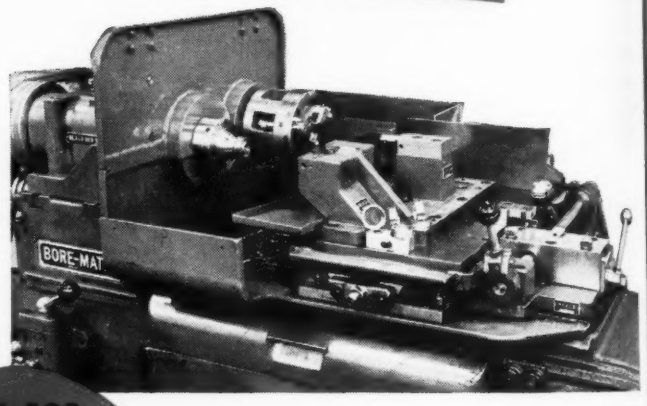
Adjustable Boring Head Mounting on Slotted Bridges.
Flexible V-Belt Head Drive Gives Wide Speed Range.
Available with Single End or Double End Bases.
Hydraulic Table Drive permits complete range of feeds.
Units of Hydraulic Box readily changed for various cycles.
Auxiliary Hydraulic Power for Cross Slides, Tool Slides, etc.
Plus
Flexible Cycles — Manual or Automatic

V. F. 2* *ALL-PURPOSE* VERSATILITY *FROM BASIC BORE-MATIC DESIGN*

BORIZE ON BORE-MATICS . . . that means improved results on all operations . . . means better accuracy, finish, production for boring, turning, facing, chamfering, grooving, fly cutting, for straight and taper surfaces, for curves and irregular shapes.

All these operations would not be possible on a machine with fixed, rigid design. On Heald Bore-Matics, basic design is unusually flexible . . . has unusual versatility that permits individual arrangement to suit specific requirements of every job.

Versatility like . . . slotted bridges holding one or more boring heads for single or multiple operation . . . flexible, adaptable drive to heads by V-belts . . . single end or double end bases for single end or double end operations . . . hydraulic feeds, infinitely variable . . . auxiliary hydraulic power to operate cross-slides, tool slides, tool back-off clamping . . . machine cycles, manual or automatic to suit your requirements. Get the facts on Heald Bore-Matics now. Write The Heald Machine Co., Worcester 6, Mass.



LOOK FOR
*V. F.
"VERSATILITY FACTOR"
In your Post War Tools
V. F. 1 — Application
V. F. 2 — Function
V. F. 3 — Tooling
V. F. 4 — Fixtures

This is *functional* versatility. Heald engineers took a standard basic single end Bore-Matic, mounted two heads on the bridge with special rotating fixtures, designed special tools, put them on a hydraulic cross-slide. Final result . . . completely automatic turning, boring, facing, necking, forming of bearing liners in two-stage progressive operations.

HEALD *Bore-Matics*

THE MOST VERSATILE MACHINE TOOL

DESIGN, CONSTRUCTION, OPERATION OF METAL-WORKING AND ALLIED EQUIPMENT

MACHINERY

The American aircraft industry produced over 175,000 fighting and bombing planes in about three years. This great achievement is one of the most important factors in our outstanding military successes. It was possible only because of the progressiveness of production men in the aircraft industry and suppliers of metal-working machinery in developing manufacturing processes to meet the special needs of the phenomenally expanding industry. July MACHINERY describes recently developed processes in the plants that build the planes themselves; the August number will supplement this production information with articles dealing with processes in factories that turn out engines, propellers, and navigation instruments.

Volume 50
Number 11

JULY, 1944

PRINCIPAL CONTENTS OF THIS NUMBER

For Complete Classified Contents See Page 260

Plastic Punches Facilitate Lockheed Metal-Forming *By George H. Prudden* 136
Boeing Technique in Stretch-Forming Rolled and Extruded Shapes *By Boyd K. Bucey* 146
Rubber Sheeting Speeds up Martin Stretching Operations *By Harry F. Vollmer* 156
Milling Douglas Integral-Eye Spar Caps from Rolled Billets *By N. A. Lombard and G. R. Gwynne* 164
Hot-Forming Magnesium Plates at Northrop *By Paul Hawley and Robert L. Gunter* 176
Thermo-Elastic Forming Airplane Parts from Phenolic Plastics *By W. I. Beach* 182
Consolidated-Vultee Bucking-Bar Development Expedites Production Riveting *By E. P. Myers* 188
Expediting Curtiss-Wright Heat-Treating, Anodizing, and Plating *By E. K. Fry* 192
Editorial Comment 200
Grinding to Ten-Thousandths Inch on a High-Production Basis *By Ralph Price* 201
Specifying Steel by Performance *By Greswold Van Dyke* 206
How to Secure Fine Surfaces by Grinding *By the Late H. J. Wills and H. J. Ingram* 208
Development of the Art of Chromium-Plating Cutting Tools 211

DEPARTMENTS

Engineering News 199
Materials of Industry 210
New Trade Literature 212
Shop Equipment News 215
News of the Industry 250

Product Index 446-464
Advertisers Index 467-468

TOTAL DISTRIBUTION
20,625

PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS
148 Lafayette St. New York 13, N.Y.

ROBERT B. LUCHARS ..... *President*
EDGAR A. BECKER.. *Vice-pres. and Treasurer*
ERIK OBERG ..... } *Editors*
FRANKLIN D. JONES ..... }
CHARLES O. HERB ..... *Managing Editor*
FREEMAN C. DUSTON ... *Associate Editor*
HOLBROOK L. HORTON... *Associate Editor*
WALTER E. ROBINSON *Advertising Manager*
BRIGHTON, ENGLAND:
MACHINERY, 17 Marine Parade

SUBSCRIPTION RATES: United States and Canada, one year, $4; two years, $7; three years, $8 (for Canada add 25 cents per year for war tax); foreign countries, $7 a year. Single copies, 40 cents except this special number, which is $1. Changes in address must be received by the fifteenth of the month to be effective for the next issue. Send old as well as new address.
Copyright 1944 by The Industrial Press.
Entered as second-class mail matter, September, 1894, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in the United States of America.
Member of A.B.P. Member of A.B.C.

16 Vita

Single pulley driv
and bearings · Ge
disconnecting a
opens and close
by inner walls ·
guides through fe
giving fly-wheel e

LANDISize
Your Threads

The many new and exclusive features of LANDMACO Threading machines combine to assure the greatest possible degree of accuracy, ease of operation and flexibility in making set-up changes.

LANDIS

THREADING MACHINERY · THREAD CUTTING DIE HEADS

ON TO VICTORY!

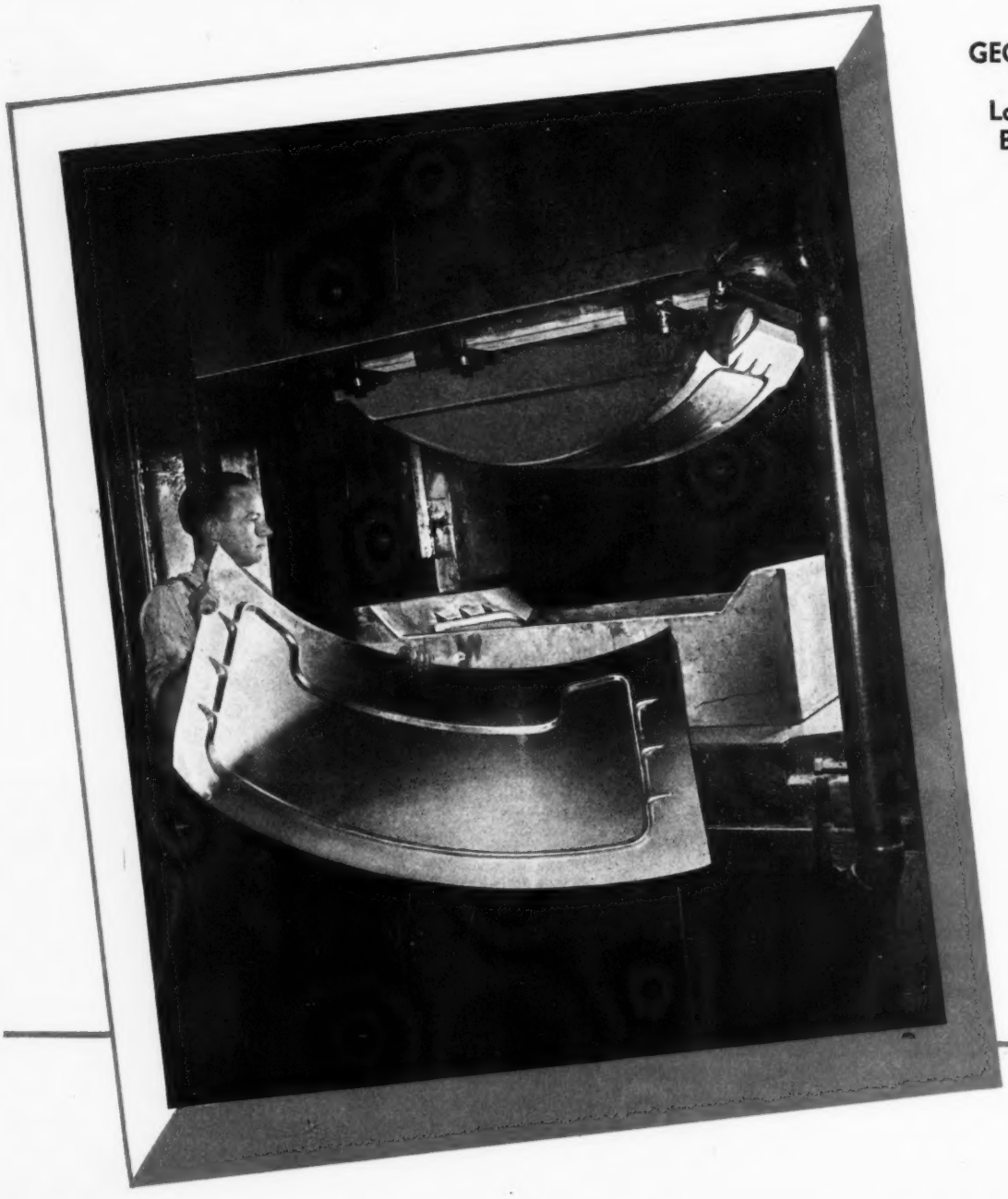
MACHINERY Vol. 50 No. 11
JULY, 1944

Official U. S. Navy Photo

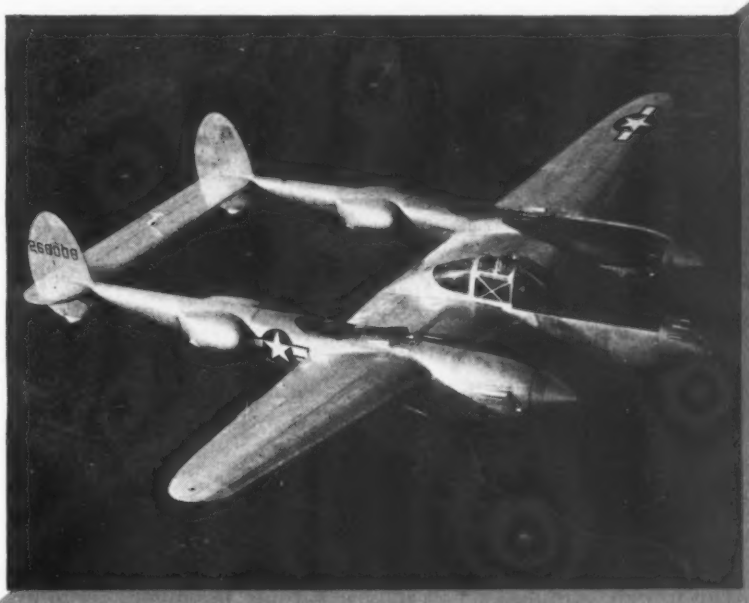
The road to ultimate victory has already been paved by the air armadas of the United Nations. Devastation hurled from the skies has crippled enemy production centers, transportation facilities, and fighting power — has made easier our battles on land and sea. Although victory is now certain, thousands more planes may be needed before the war is finally won. The aircraft industry is even better prepared today than it was a year ago to meet all demands. That industry does not rest on well won production laurels. It is constantly developing new manufacturing methods to overcome the severe handicaps imposed by the drafting of skilled workmen into the armed services, and, at the same time, to produce better and better planes. Some of these new methods are fully described in this issue of MACHINERY. Additional articles dealing with developments in airplane-engine and propeller factories will be presented in a second Aircraft Production Section, to be published in August MACHINERY.

Plastic Punches Facilitate Metal-Forming . . .

By
GEORGE H. PRUDDEN
Works Manager
Lockheed Factory A
Burbank, California



Lockheed



More Than Two Years of Experience with Punches Made of Thermoplastics and Used in Conjunction with Kirksite Dies have Proved that Important Advantages are Attainable from This Practice

APPROXIMATELY two years ago, the Lockheed Aircraft Corporation, Burbank, Calif., commenced experimenting with plastics for drop-hammer and hydraulic press punches used in forming sheets of aluminum alloy in an effort to find a satisfactory substitute for critical metals. Extensive use of plastic punches in combination with Kirksite dies during the interval has proved that important advantages can be derived from this practice.

The result has been that plastic punches are now considered permanent tooling in Lockheed factories. A considerable number of them are now being used in production operations on B-17 and PU bombers, P-38 fighters, and the giant record-smashing Constellation transport, and plans have been made for still further increasing their application. When this program has been completed, at least 80 per cent of the drop-hammer and hydraulic press drawing punches will be made of plastic.

Experience has shown that plastic punches will form metal parts in Kirksite dies more consistently than the lead punches formerly in exclusive use. Because plastic punches are more pliable than lead punches, they give more readily and force the metal being formed closely into the die impressions, in this way somewhat duplicating the effects obtained by using rubber pads in forming operations. Work-pieces can, therefore, be drawn or formed to closer dimensional tolerances, particularly as far as beads and similar details are concerned.

Another important advantage derived from plastic punches is the greatly reduced cost of preparing them for use. As in the case of lead punches, it is the practice to pour the molten plastic into a finished Kirksite die. When this step has been completed and the material has solidified, the plastic punch is ready for immediate use.

With lead punches, on the other hand, it is necessary to scrape the punch down until an amount of stock has been removed from all work surfaces equal to the thickness of the metal to be formed. Otherwise, the lead punch could not

Fig. 1. Hydro-press Operation in which a Plastic Punch Produces Beads in Curved Panels Close to Dimensional Specifications without Showing Any Signs of Wear

be forced into the Kirksite die without marring the punch surfaces. The plastic punch, however, can be compressed sufficiently to compensate for the metal thickness, because of its inherent elasticity. It is necessary only to scrape a plastic punch at points where the contact between the punch and die may be too close.

Although the plastic compresses, it readily returns to its original shape, and this accounts for its good metal-forming qualities. This elasticity enables plastic punches to retain their original shape even down to small details, whereas surfaces of small radius on lead punches are generally beaten back to larger radii and reduced heights. It is the practice to place rubber strips in dies to compensate for such deformation of lead punches and to insure that the sheet metal will be forced to the bottom of the die impressions. The use of rubber for this purpose causes still further deformation of punch details, with the result that a new lead punch is often necessary for restriking formed work.

The economies obtained by the use of plastic punches on a rope drop-hammer can be emphasized by pointing out that steps involved in forming 100 identical parts, first by using a lead punch and Kirksite die, and then by employing a plastic punch and Kirksite die. The procedure followed in using the lead punch and Kirksite die was as follows:

1. Set up die in hammer—approximately 30 minutes.

2. Strike 100 parts one time each—approximately 1 hour.

Fig. 2. Using a Plastic Punch in a Drop-hammer Operation in which the Work-piece is Fed Gradually across the Die Surface during Successive Strokes of the Punch

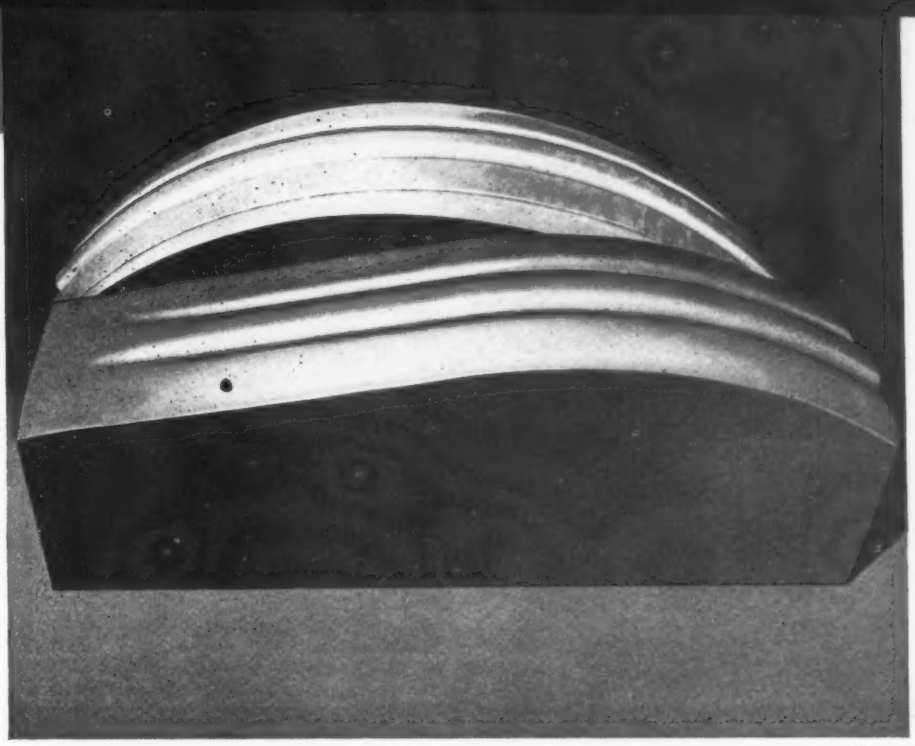


Fig. 3. Close-up View of Plastic Punch Used in Operation Seen in Fig. 2, which Shows how Depth of Bead-forming Groove Increases along Length of Punch

3. Tear down set-up and remove punch and die from hammer—approximately 15 minutes.

4. Cast new lead punch—about 2 1/2 hours.

5. Anneal 100 parts—about 45 minutes.

6. Set up die in hammer—about 30 minutes.

7. Finish-form 10 parts—approximately 6 minutes.

8. Finish-form 90 parts (using rubber to force the metal into die impressions of small radius because the lead ridges on the punch have spread after forming the first 10 parts)—approximately 2 hours.

The total time for carrying out this operation was 7 hours and 36 minutes.

When the operation was performed with a plastic punch and Kirksite die, about 30 minutes was required for setting up the die on the hammer, but the 100 parts were produced in 1 hour, only one hit being necessary for each part. Punch dismantling and resetting, an annealing operation, a restriking operation, foundry time consumed in casting a second punch, and the use of critical metals were all eliminated. Similar savings are effected through the use of plastic punches in hydraulic press operations.

Plastic punches are only one-tenth as heavy as lead ones, and they can, therefore, be handled far more easily. Still another advantage is derived from the fact that when a plastic punch is brought into sharp contact with the work and die in drop-hammer operations, only a dull thud is emitted, instead of the sharp ringing sound usually produced when both the punch and die

Fig. 4. A Drop-hammer Operation in which a Plastic Punch Forms a Joggle around Sheets that are Formed into Window Frames without Any Signs of Wear

Fig. 5. Plastic Punch of a Type that can be Cast with Ease, Ready for Immediate Use, and that would Necessitate Considerable Fitting if Made from Metal

Fig. 6. Hydraulic Press Equipped with a Die Set in which the Comparatively Large Draw-ring and the Punch Member in Center of Draw-ring are Made of Plastic

are made of metal. This reduced noise also tends to alleviate operator fatigue.

Excellent results have been obtained by casting plastic punches from Nos. 8 and 9 Plastalloy and Tenite II. The first-mentioned of these plastics are made by the Plastalloy Co., Hollywood, Calif. The No. 8 compound is used for drop-hammer punches, and the No. 9 compound for punches to be used on hydraulic presses. Tenite II is a cellulose acetate butyrate made by the Tennessee Eastman Corporation, Kingsport, Tenn. Research has proved that either of these plastics may be used for most punches required for forming aluminum and its alloys. However, experiments indicate that Plastalloy is not applicable for forming stainless steel, and investigations of Tenite for this purpose have not yet been completed.

Typical applications of plastic punches on hydraulic presses and drop-hammers will now be discussed. Fig. 1 shows a Tenite plastic punch attached to the ram of a Bliss 650-ton hydraulic press for forming flat duralumin sheets into curved and beaded panels in a Kirksite die supported by the press platen. This is the type of operation in which a plastic punch is especially advantageous, because it will satisfactorily produce the beads to specified dimensions in an indefinite number of panels. The plastic punch shown is approximately 4 feet in length by 16

inches maximum thickness. The beads produced are 1/2 inch deep by 1 inch maximum width. The panels are formed from 0.051-inch thick duralumin sheets.

The punch seen in Fig. 2 in use on a rope drop-hammer is made from No. 8 Plastalloy, the die being of Kirksite. This punch and die are designed for progressively forming a sheet of duralumin to the required curvature, with two rather deep beads, as the sheet is advanced in increments along the length of the die between successive strokes of the punch. In Fig. 3 may be seen a close-up view of this punch and a typical piece of formed work, the latter being 24 S-0 Alclad, 0.051 inch thick.

A plastic drop-hammer punch used for forming window frames from 24 S-O Alclad is illustrated in Fig. 4. A feature of this operation is the forming of a single joggle entirely around the work-piece near its perimeter. In a somewhat similar operation, but one in which two joggles had to be formed around the work, six hours was required to produce 107 frames when a lead punch was employed. Each piece was struck once with the punch, and then restruck after strips of rubber had been laid on the work to insure that the joggle would be formed to the specified depth in the die.

After this restriking, the parts were still unsatisfactory, so that a new lead punch had to be

Fig. 7. Another Punch and Die Set-up Similar to that Shown in Fig. 6, the Rather Large Blank-holder or Pressure Pad and Punch being Cast from a Thermoplastic

Fig. 8. View Looking into the Double-boiler Kettle of Equipment Seen in Fig. 9, Showing the Agitator that Keeps the Plastic in Motion, to Prevent Burning

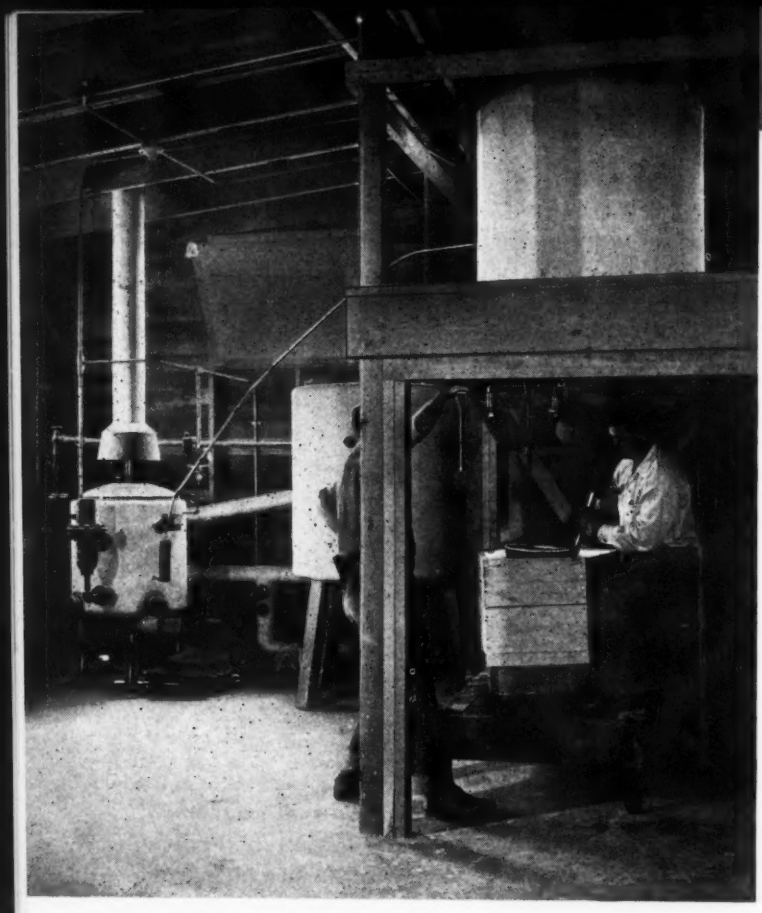


Fig. 9. Equipment Employed for the Melting and Mixing of Thermoplastics prior to Casting into Punches for Use on Drop-hammers and Hydraulic Presses

cast and all of the work-pieces annealed, after which two operations similar to the first two were necessary in order to form the entire lot of window frames properly. The difficulty arose from the fact that the lead punches would flatten out along the edges that produced the joggles.

The next lot of 107 pieces was formed by a plastic punch in the same Kirksite die within a total of only seventy-two minutes. Each frame was struck twice in immediate succession.

A plastic punch of a design that would require hours of work to fit to the die if it were made of lead or zinc is seen on the platen of a Clearing hydraulic press in Fig. 5. When such a punch is made of metal, it is necessary to scrape the various surfaces until they closely fit the die and a sample hand-made piece of work, as shown by the application of Prussian bluing. When made of plastic, no such fitting is necessary. The punch illustrated has lasted for the production of several hundred parts without any correction of the forming surfaces being required.

Hydraulic press operations in which the draw-rings or pressure pads are made from plastic materials are illustrated in Figs. 6 and 7. The punch at the center of the draw-ring in both of these set-ups is also made of plastic, while the die on the press rams is of Kirksite. Draw-rings made of Plastalloy have been only partially satisfactory, and are not recommended for all applications, except in the case of prototype tools or in instances where the accuracy of a die is being checked. Sufficient experiments have not yet been performed on Tenite II to determine whether the plastic could be recommended unreservedly for use as draw-rings.

Two distinct Plastalloy materials are combined to form the casting compound for punches. This practice is followed to facilitate the melting, the materials being termed Plastalloy A and Plastalloy B for convenience. The former has a

Fig. 10. Wooden Sides Covered with Tin are Built up around the Kirksite Die on which a Plastic Punch is to be Poured, so as to Retain the Plastic until It Becomes Solid

low melting point, while the melting point of Plastalloy B is considerably higher. Plastalloy A is first melted to a liquid state in the double-boiler type of heater seen on the platform in Fig. 9, after which the B material is added slowly. The mixture is agitated from start to finish, as shown in Fig. 8, to prevent burning. Pieces of hard plastic reclaimed from used punches may be added while the mixture is being melted. The mixture is heated to 400 degrees F., and then is allowed to cool to 350 degrees F. while being agitated continuously. Cooling takes about forty-five minutes, after which the plastic is ready to cast.

Tenite II is supplied in the form of pellets or granules for casting punches. Several grades of materials are available, ranging from Tenite II S-15 to Tenite II H-5. The soft or "S" materials may be melted without the aid of a plasticizer, but melting is accomplished far more rapidly by the use of a liquid plasticizer developed by the Lockheed tool research department. By increasing or decreasing the amount of plasticizer, the physical properties of the final cast material can be controlled.

In melting Tenite, a predetermined amount of No. 4 plasticizer is poured into the cooker and allowed to heat to 400 degrees F., after which Tenite H-5 is added slowly (at an average rate of 5 pounds per minute). This material can be poured at a temperature of 400 degrees F. Reclaimed Tenite may be added to the mixture at any time after the material has dissolved. Melting of Tenite is also performed in the double-boiler processing kettle mentioned above.

Dowtherm is used as the heating medium in the plastic melting operation. It is heated by the boiler unit seen at the far left in Fig. 9, and is pumped to the kettle on the platform, where it passes through coils for heating the plastic mixture and then returns to a sump tank seen in the central background of the illustration. The paddle wheel in the melting kettle is driven at a slow speed and scrapes within 1/8 inch of the kettle wall. The processed plastic is released from the kettle through a gate at the bottom, which may be seen in Fig. 12.

Preparation of a Kirksite die for casting a plastic punch is much the same as for casting a lead punch, except that it is unnecessary to preheat the die or to spray it with whiting. Ordinary wooden sides are built up around the die, as shown in Fig. 10, and these sides are lined with tin or with cellophane. The sides are usually extended about 10 inches above the highest point of the die, with the result that a thicker punch is obtained than is usually cast from lead. Experience has shown that impact is better absorbed and transmitted when a plastic punch is about 15 per cent thicker than would be the case with a lead punch. This rule applies to drop-hammer punches only, the shut height of a hydraulic press being the determining factor for a plastic punch to be used in such an application. When fillets are necessary between a die and the wooden sides of a mold, they are made with molder's clay.

After a die has been prepared as shown in Fig. 10 and located directly beneath the gate of the melting kettle, the plastic is cast into the die

Fig. 11. In Casting a Plastic Punch, the Plastic is Poured through a Funnel, the Nose of which is Kept beneath Surface of Poured Material to Insure Uniform Cross-section of Punch

through a tin funnel, as shown in Fig. 11. Once this operation has been started, the lower end of the funnel is kept below the surface of the plastic to avoid lapping of the material, which would tend to produce weakened cross-sectional planes. Trapping of air, with resultant blowholes, is also avoided by exercising caution in this respect.

Immediately after a punch has been cast, a pressure cover, such as the operator is seen holding in Fig. 10, is placed on top of the mold. This cover has wooden cores attached, also covered with tin, that form impressions in the top side of the punch for receiving inserts. This applies only to punches intended for use on drop-hammers, because inserts are not necessary on punches for hydraulic presses. During cooling, weights are maintained on the pressure cover to force the plastic material to adhere closely to the contours of the die while cooling, thus preventing shrinkage and insuring against blowholes being formed by pocketed air.

Cooling requires considerable time, depending upon the size of the punch casting, the total time required for casting and cooling a plastic punch being somewhat more than that necessary for producing a lead punch. As soon as the outer surfaces of the plastic punch have solidified, the wooden box can be removed. The cover plate and its cores are taken off when the punch has hardened through its entire cross-section and there is no longer danger of dimensional change.

After a punch has hardened, metal inserts are located in the cavities produced by the cores of the pressure cover. To insure accurate positioning, these inserts are first fastened to a spider, such as seen in Fig. 13, by means of studs, and the spider is laid across the top of the punch. Melted plastic is then poured around the inserts to fuse them to the walls of the cored pockets.

The final operation in producing a plastic punch is to heat the die to a temperature slightly above the melting point of the plastic with the punch removed from the die. Then the punch is located on the die and pressure is applied by means of ordinary clamps, such as are employed by cabinet-makers. This causes the surface next to the die to be slightly remelted, so that the punch fills in areas of the die from which it may have shrunk in the initial cast. A water spray quench is next applied to cool the punch and die as rapidly as possible. This operation, which is called "searing," compensates for all shrinkage and insures the fit between the punch and die. In the event that the face of a punch becomes marred or deformed during use, a similar searing operation will reproduce the face just as accurately as when the punch was new, thus eliminating the necessity of recasting the punch.

Since the top surface of the cooled plastic punch is not ordinarily smooth, it is the custom to machine this surface with the punch resting on the die, so that the top surface of the punch will be finished parallel to the bottom of the die. This machining operation is done either on a planer or a radial drilling machine equipped with a fly cutter.

When plastic punches were first placed in use, considerable difficulty was experienced when the

Fig. 12. When the Punch Mold has been Filled Completely, the Funnel is Withdrawn from the Still Liquid Plastic. This Illustration also Shows the Gate of the Melting Kettle

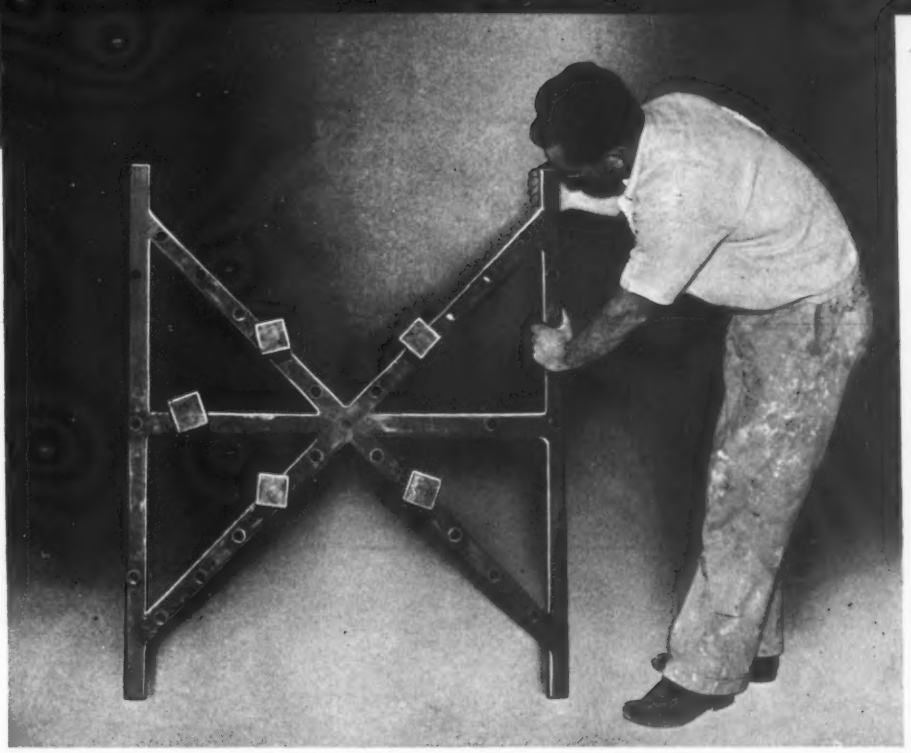


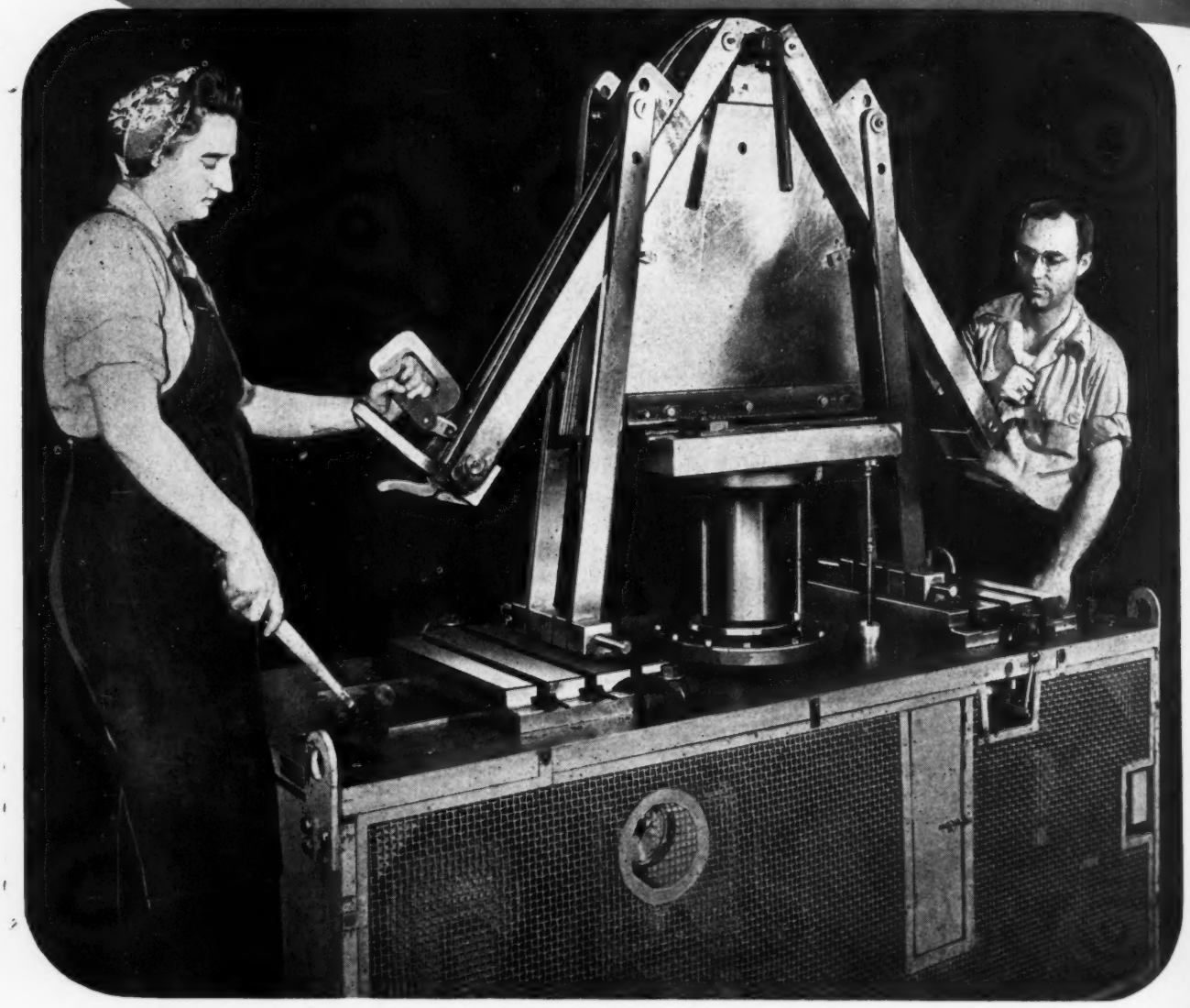
Fig. 13. The Inserts Required for Attaching a Plastic Punch to a Drop-hammer Ram are Located in Cores in the Punch by the Use of a Spider Such as Shown

punches were taken from outdoor storage areas and placed into immediate use. Experience has shown that Plastalloy punches should not be worked at temperatures lower than 70 degrees F., because they become brittle at lower temperatures and will fracture from hammer blows. On the other hand, Tenite II seems to be unaffected by temperatures considerably lower than 70 degrees F.; as a matter of fact, the tensile strength appears to increase with decreased temperatures. Tenite also has a higher melting point, and therefore can be used at higher temperatures.

Neither of the thermoplastic materials from which Lockheed punches are made should be ground or sanded, because of the heat generated by tools used in such operations. On the other hand, they may be drilled, tapped, planed, or cut with machines or hand-operated woodworking tools.

Plastic punches for sheet-metal forming are obviously still in the pioneer stage, but their increasing application on drop-hammers and hydraulic presses is forecast by the fact that the average plastic punch will form parts accurately until such time as the die itself becomes obsolete. Plastic punches are in use in Lockheed factories in sizes as large as 13 feet 6 inches long by 18 inches wide by 8 1/2 inches thick. A punch of these dimensions has a weight of 2000 pounds, which seems to indicate that the possibilities for using plastic punches are almost limitless.

BOEING TECHNIQUE FOR ROLLED AND



Principles Followed in Determining the Proper Paths of Cams and Levers for Controlling Stretch-Forming Operations, and Rules to Observe in Order to Avoid Distortion of Sections

By BOYD K. BUCEY, Tooling General Superintendent
Boeing Aircraft Co., Seattle, Wash.

IN STRETCH-FORMING EXTRUDED SHAPES

STRETCH-FORMING as the term is used in aircraft factories, is primarily a process of producing uniform and irregular curves in rolled or extruded shapes of aluminum alloy by bending the material over a form of the required shape and elongating the material until it is stressed to a point somewhere between the yield point and the ultimate strength. The elongation is accomplished by applying forces that place the rolled or extruded shape in direct tension. Two means of applying direct tension are in common use—either through hydraulic or pneumatic pressure or by mechanical devices.

When a mechanical device alone is used, the amount that the part is stretched is controllable, but the pressure is not. On the other hand, when stretch-forming is performed by the use of either a hydraulic or pneumatic cylinder and without auxiliary mechanical equipment, the pressure applied to the shape can be controlled, but not the elongation of the material. Stretch-forming operations in plants of the Boeing Aircraft Co. are performed on machines that utilize hydraulic pressure for bending the shapes around forms, and also cam- or lever-controlled devices for imparting the stretching action necessary to hold the formed sections to required outlines without spring-back.

Best results have been obtained by stretch-forming duralumin sections in the S-O heat-treated condition. The stretch-forming possibilities of any section depend primarily upon the differential elongation and the ultimate tensile strength of the section. Generally speaking, any shape can be stretch formed if the material is of uniform section throughout its length at the time of forming, if it is not to be formed into reverse contours, and if the differential elongation will be less than 8 per cent.

The differential elongation is determined by measuring the length of the top fiber of the bent piece (see diagram *X*, Fig. 5) and the length of the bottom fiber, dividing the difference between the two by the length of the bottom fiber, and translating the resulting fraction into a percentage figure. For example, if the top fiber of a stretch-formed piece measures 38 inches and the bottom fiber 36 inches, the differential elongation will equal (38—36) $\div$ 36 $\times$ 100, or 5 5/9 per cent.

Official U. S. Army Air Forces Photo

Fig. 1. Stretch-forming Operation on a Boeing 10-ton Hydraulic Press. The Illustration Shows the Gripping-jaw Levers in the Horizontal or Loading Position

Fig. 2. Another Stretch-forming Operation, in which the Movement of the Gripping Jaws is Controlled by Cam Slots on the Stretch-block and Hold-down Arms Anchored to the Machine Table

If a part is to be bent to one radius only, the differential elongation is determined by simply dividing the depth of the section by the radius of the bottom fiber and translating the value into percentage. The first step in designing a stretch-form is to lay out the work-piece in order to determine the differential elongation, and then develop an involute curve of the bottom fiber. This involute is the basis for all elongation computations. It is an arc along which every point represents another point on the bottom line or fiber of the part.

The involute is used to develop a path for the movement of the jaws on Boeing machines which grip the ends of the rolled or extruded shape during stretch-forming. In the heading illustration and Fig. 1, for example, a machine is shown in which the movement of the gripping jaws is controlled by levers when the ram of the machine rises. Figs. 2 and 4 illustrate another arrangement, in which the movement of the gripping jaws is controlled by levers and cam slots when the machine cam rises.

In laying out the involute, the neutral axis or "centroid" is extended beyond the end of the stretch-form to a point *A*, as illustrated in diagram *Y*, Fig. 5. *A* represents the point where the front of the work-gripping jaw will clear the end of the stretch-form. It determines the position of the jaw at the end of the stretch-forming operation. The distance *AB* is then laid out to correspond with the elongation of the bot-

Fig. 3. Loading a Filler Constructed of Aluminum Links into the Channel of a Heavy Extruded Section to Prevent Collapse of the Channel Walls during Stretch-forming

Fig. 4. Another View of Stretch-forming Machine Illustrated in Fig. 2, which Shows the Position of the Gripping-jaw Links when the Ram of the Press is at the Top of Its Stroke

tom fiber. This is largely an arbitrary value which depends upon the curvature of the part and the elongation that is safely obtainable in the material being stretch-formed.

The involute curve *BC* is then generated from the bottom fiber of the finished part. *A* and *C* will be the two end points of the jaw path. The final step is to develop an arc or cam line to connect points *A* and *C*. A cam constructed to conform with this arc will cause the corresponding gripping jaw in a stretch-forming operation to produce stretching strains on the work in the desired manner. If the gripping jaws of a stretch-forming machine were made to follow the involute exactly, neither stretching nor compression would occur along the bottom fiber of the extruded or rolled shape. If the jaw path is made outside of the involute, stretching will occur, and if it is inside of the involute, compression will occur. If the jaw path is laid out from the involute in the manner outlined, any percentage of stretch can be obtained at any point along the bottom fiber of the section. Levers or cams can be designed to compel the gripping jaws to follow the desired path.

It is often necessary to pre-stretch extruded or rolled shapes before forming is started. This serves to straighten the material before it enters the grooves in the stretch-form, and obviates slippage of the shape in the jaws during the forming and stretching. When a part is to be formed to a shallow contour, complete stretching

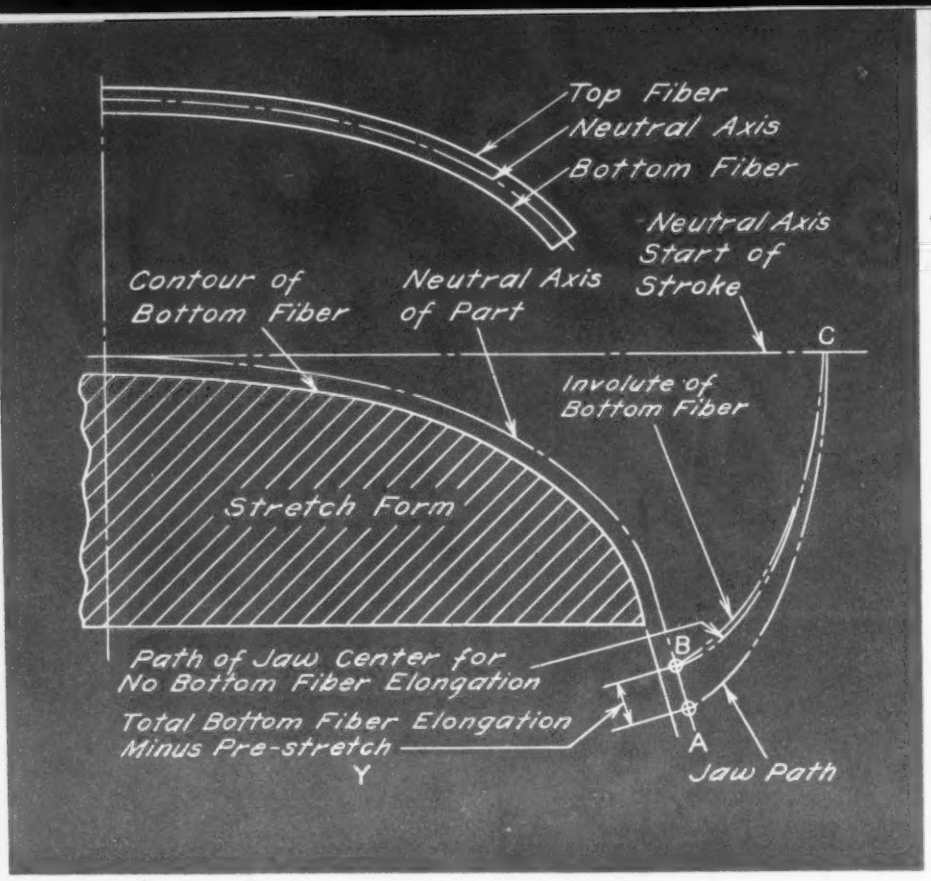


Fig. 5. Diagrams Showing Manner of Determining the Arc to be Followed by Gripping Jaws of Boeing Stretch-form Presses during Bending and Stretching of Rolled and Extruded Shapes

may be accomplished before the forming is started. This procedure is usually necessary in order to elongate the material sufficiently to eliminate any spring-back after the short stroke required in producing the shallow-formed work. Pre-stretching occurs while the jaw pivot arm moves through distance *A* in diagram *Y*, Fig. 7. From diagram *X* it will be seen that the pivot arm is a link that connects the gripping jaw with the stretch-form.

It will be understood from the foregoing that the total enlongation given to a part consists of the pre-stretch, the differential elongation, and an additional amount required to eliminate spring-back. Practice has proved that this point is reached when the material has been stretched from 8 to 10 per cent of its original length.

In most instances, a desirable jaw path can be obtained with a pivot arm set-up such as shown in diagram *X*, Fig. 7. However, if the contour of the part is extremely irregular, a cam may be required to provide more stretch in areas that are formed to short radii or to make the gripping jaws follow the involute more closely than is possible through a lever action alone. Such a cam set-up is shown diagrammatically in Fig. 6 and photographically in Figs. 2 and 4.

Two-operation forming is sometimes necessary to produce parts to extremely short radii, especially when there is a short radius near the

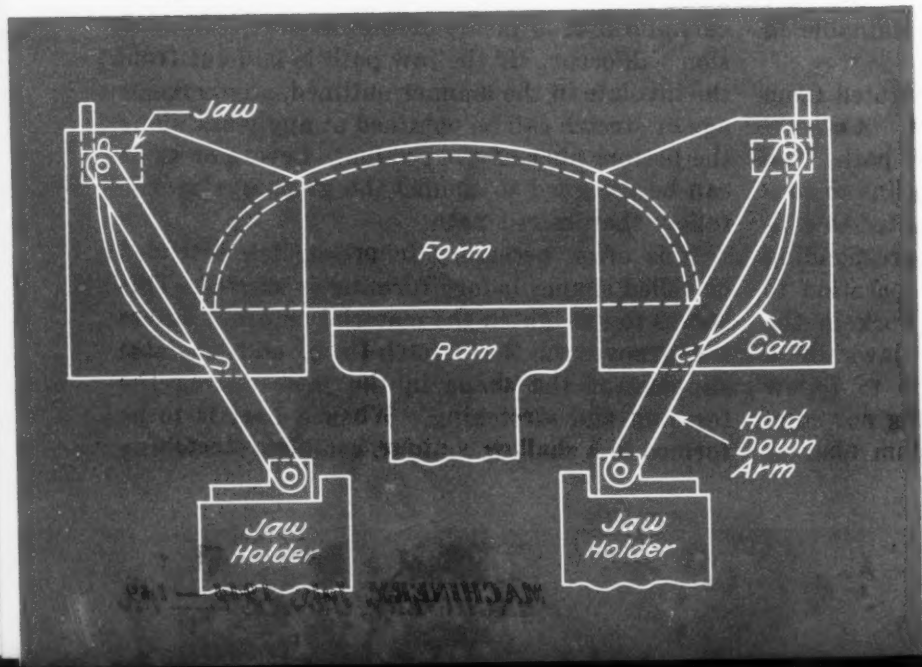


Fig. 6. Arrangement of the Links and Cam Slots that are Used in Operations Such as Shown in Figs. 2 and 4, for Controlling the Movement of the Work-gripping Jaws

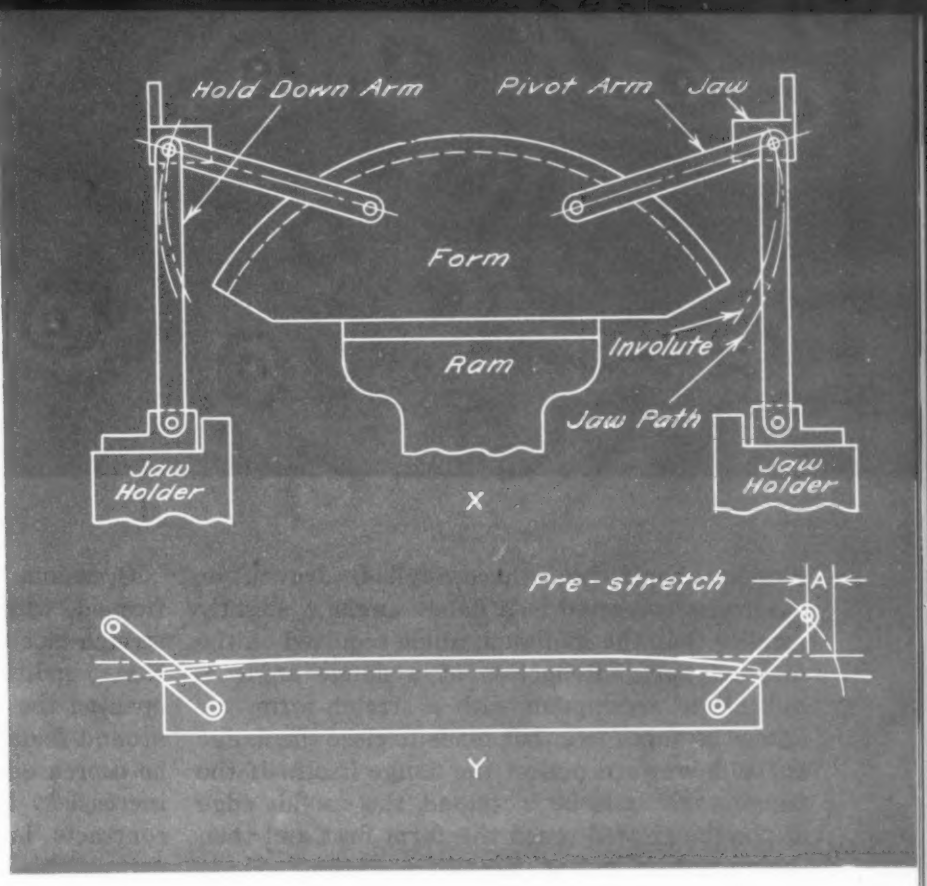


Fig. 7. Diagrams that Show the Arrangement of the Levers and Links for Controlling the Movement of the Work-gripping Jaws when the Press Ram Rises to Start the Stretch-forming Operation

center of the part. Two operations are also required for parts having a great depth of contour which often become work-hardened before stretch-forming has been completed. Such work-pieces are likely to break or possess an undue amount of spring-back. The sketches in Fig. 10 represent two such operations and the shape of the work-piece after each operation has been performed.

After a stretch-form has been developed, a few precautions may be necessary to insure the production of a part whose cross-section is dimensionally correct. When material of a channel cross-section is to be produced in a female stretch-form, that is, a form with grooves to receive the material, a filler should be used in the channel to hold the channel sides snugly against the walls of the groove. Such a filler will prevent the channel sides from dishing or bulging. When the section is shallow, a straight filler block may be used. Usually, however, the filler should be constructed of links, as seen in Fig. 3. This permits the filler to be bent with the part.

Hat sections are a common form of channel that is bent and stretched in aircraft work. These sections are generally formed with the flanges on top, as shown in diagram *X*, Fig. 9, and frequently have angles of various degrees between the flanges and the side walls. The hat

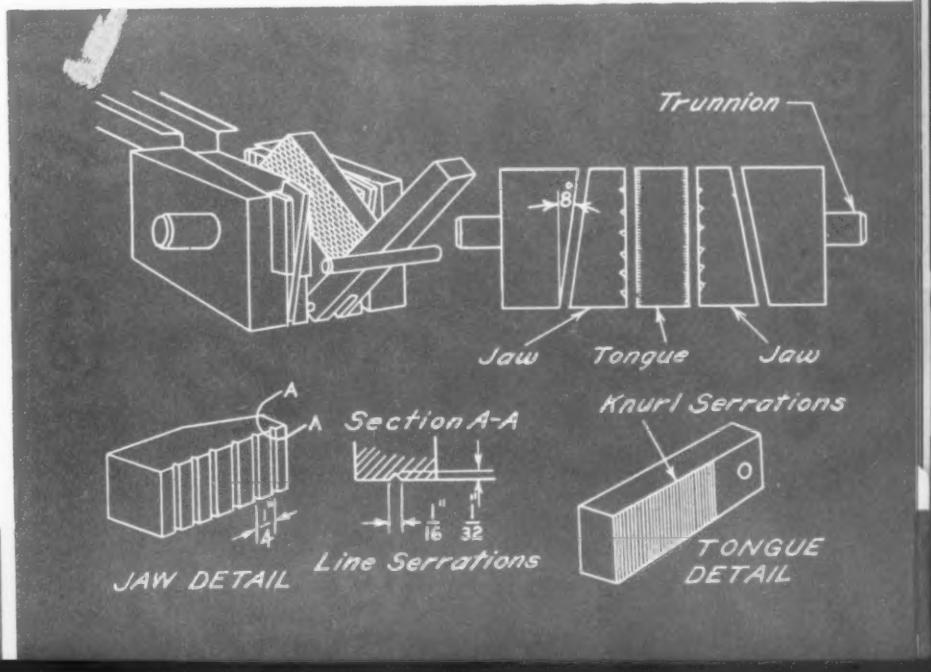


Fig. 8. Typical Design of Work Jaws Employed in Stretch-forming Rolled and Extruded Shapes, the Wedge Type Grips being Made with Line and Knurl Serrations

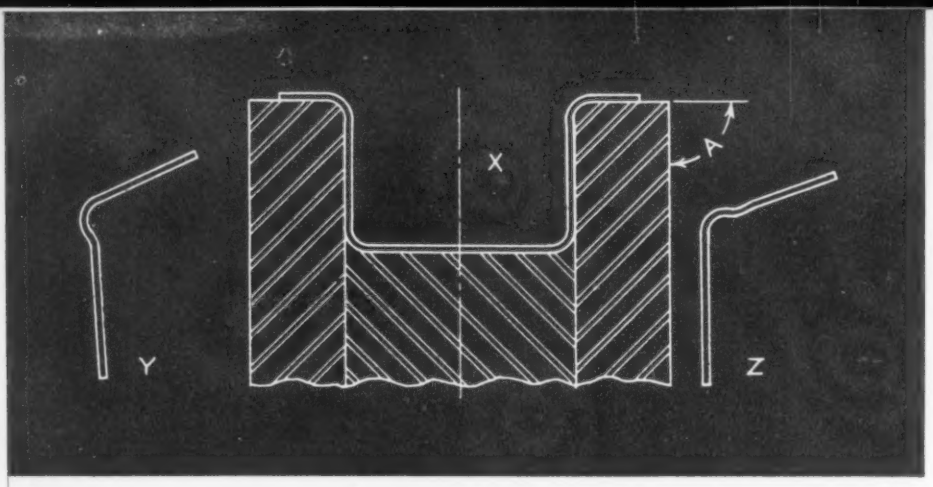


Fig. 9. Diagrams which Indicate the Distortion that may Occur in Channel Shapes when an Attempt is Made to Increase the Flange Angles in Stretch-forming Operations

section should be braked, rolled, drawn, or otherwise corrected to a flange angle *A* slightly smaller than the minimum angle required on the finished part. Reduction of a flange angle is difficult to accomplish with a stretch-form, because the only force that tends to close the flange is the downward pull of the flange itself. If the flange angle is to be increased, the outside edge of the flange will touch the form first and then the downward pull of the entire section will act to form the angle. It is advisable not to attempt to increase a flange angle more than 5 or 6 degrees on a stretch-form.

Because the original rolling of the section produces local strain-hardening at the bent corners, the bending action that occurs when a flange angle is increased, will not take place in the bent corners, but rather in the area adjacent to them. If this occurs in the channel side walls, a sharp bulge will be formed, as indicated in diagram *Y*, and if it occurs in the flange, the latter will be dished, as shown in diagram *Z*.

Occasionally a channel or hat section must be formed with the flanges down over a male stretch-block, as illustrated at *X*, Fig. 11. The same conditions exist with regard to closing or opening the flanges as when the section is bent around female forms, except that the angles can be decreased far more readily than they can be increased. However, the body of the section contracts laterally in proportion to Poisson's ratio. This causes the side walls to close toward each other. For this reason, the thickness of the form between the side walls of the material should be reduced in the regions of the greatest amount of stretch. If such an allowance is not made for lateral contraction, distortion of the body and side walls similar to that indicated in diagram *Y* may result.

There will be a certain amount of spring-back in any part made by stretch-forming when the tension is released at the end of the stretching stroke. This is true regardless of contour, depth of section, or amount of elongation. It is, there-

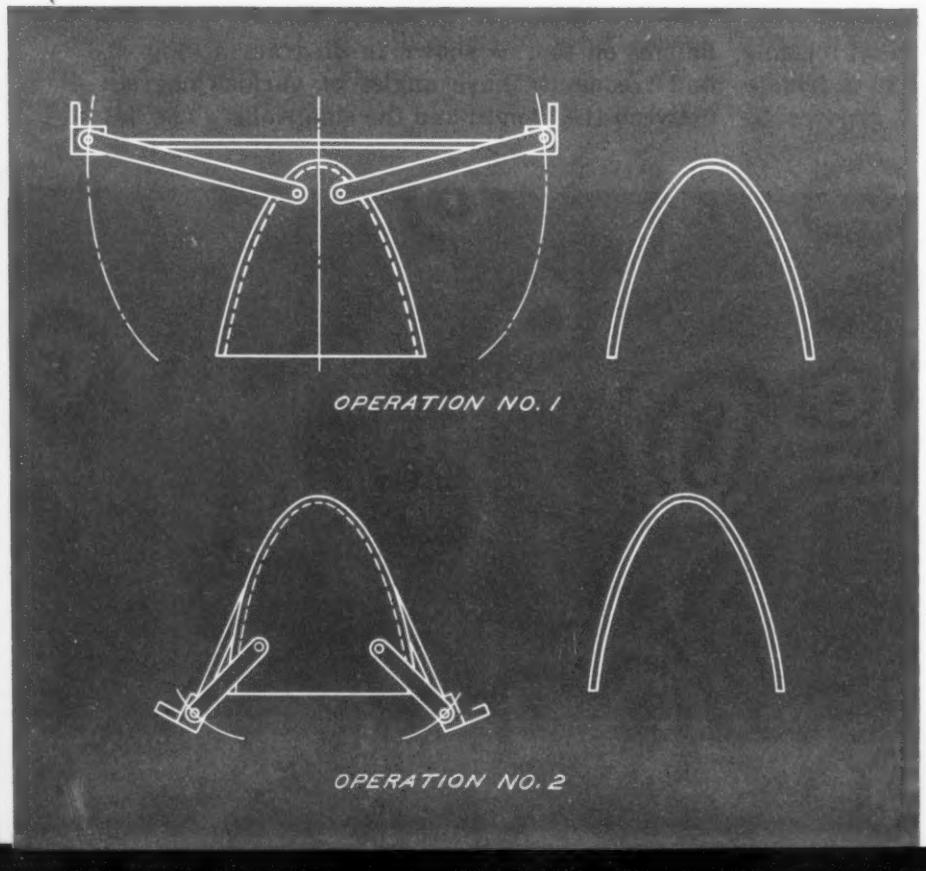


Fig. 10. Diagrams which Indicate the Type of Work that Frequently Necessitates Two Stretch-forming Operations

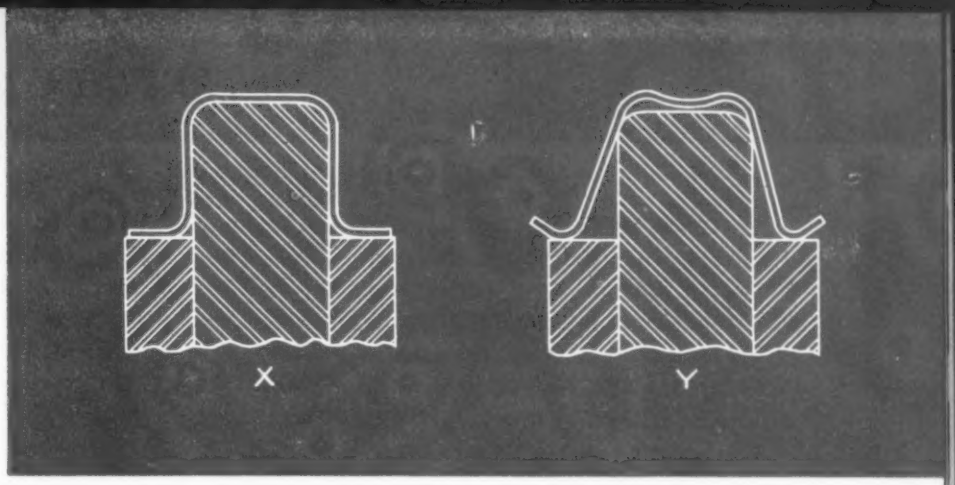


Fig. 11. Diagrams that Indicate the Distortion of Hat Section Bodies or Side Walls when No Allowance is Made on Stretch-forms for Lateral Contraction of the Section

fore, necessary to compensate for spring-back in the shop when a new stretch-form is being tried out. This is accomplished in the same manner as any form or draw die is developed. A few parts are formed on the die as first made, and checked for contour. The die is then reworked to over-bend the part sufficiently to allow for the amount of spring-back indicated from the trial parts.

Proper jaw design is essential to satisfactory stretch-forming. The primary requirements are that the jaws exert a straight pull on the section, and that they do not permit any slippage of the work. If slippage occurs, the section will not be elongated the required amount and the compressive forces will cause wrinkles to form.

A great variety of jaw designs can be developed around basic wedge type grips having serrated and hardened gripping surfaces. The section should be gripped in a manner that will cause as little deformation as possible. For example, a channel can be satisfactorily gripped on the side walls alone if a tongue or filler part of some sort is placed inside the section to prevent collapse of the walls. Such an arrangement is shown diagrammatically at the upper left in Fig. 8.

Some of the more complicated extrusions necessitate involved jaw designs in order to obtain a sufficient amount of gripping surface. The gripping surface should be compactly arranged to obtain as much area as possible without excessive length and so that the center of the gripping surfaces will fall approximately on the neutral axis of the section.

Jaw serrations should be about 0.015 inch deep and 0.032 inch apart for gripping light-gage sections up to 0.040 inch in thickness. The serrations are made 0.023 inch deep and about 0.050 inch apart for sections of heavier gage. The length of the jaw gripping surfaces is made from two to two and one-half times the width, and the width is equal approximately to the depth of the section.

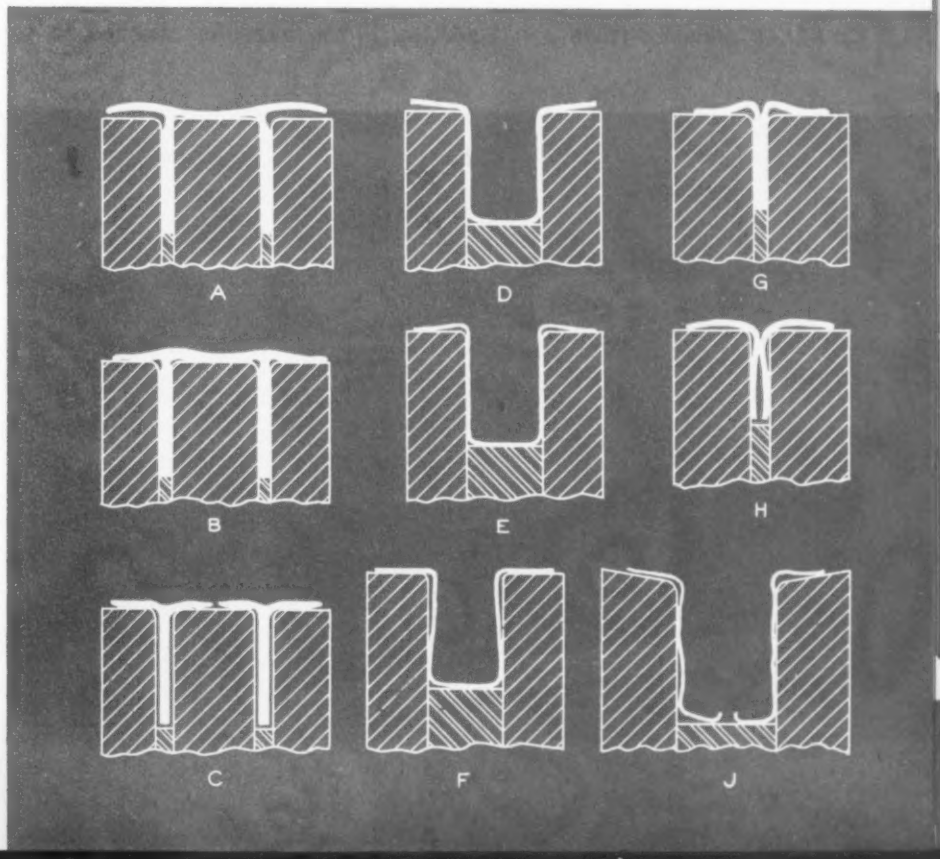


Fig. 12. Diagrams Showing Kinds of Distortion that Occur in Stretch-forming if the Forms are Not Properly Designed

Two types of serrations are used on Boeing gripping jaws—line and knurl serrations. The type of serration adopted depends upon the amount of gripping surface available. If the section is such that only a small gripping area can be used, knurl serrations are employed, but if the area is sufficiently large, combined knurl and line serrations are generally adopted.

The lighter the serrations, the easier it is to open the jaws at the completion of an operation with the section in tension. However, since the first consideration in jaw design is adequate gripping power, the designer must be sure that the serrations are deep enough to be effective.

Typical section deformations that occur in stretch-forming when the stretch-blocks are not properly designed are shown diagrammatically in Fig. 12. Diagram *A*, for example, shows a case where the central member of the stretch-form is too wide for a PI-section, with the result that the flanges on top of the section will buckle and rise relative to the form. Diagram *B* represents a case where the fillers provided under the legs of the PI-section are too high or where there is insufficient clearance between the center and side members of the stretch-form. Diagram *C* is an instance where there is too much clearance between the central and side members of the stretch-form.

Diagram *D* shows how the flanges of a hat section will rise if the central member of the stretch-form is too low, while diagram *E* illustrates what happens if the central member is too high. Diagram *F* shows the result when the filler placed within a hat section is too narrow.

Diagram *G* indicates the distortion that occurs in stretching two angles at the same time when the filler at the center of the stretch-form is too high or the space provided for the angle legs is not wide enough. Diagram *H* shows how angles will be distorted if the filler is too thick in the center of the stretch-form.

Diagram *J* shows at the left how a J-section is distorted when the central member of the stretch-form is too low, and at the right, the result when the central member is too high.

In the operation shown in Fig. 1 and in the heading illustration, a wing chord for a hat section 1 1/2 inches high by 1 3/8 inches across the flanges is being formed. The machine is a 10-ton press of Boeing design with a hydraulic ram that rises to push the stretch-form against the hat section. The latter is held between jaws at the end of two levers or pivot arms that are shown in the horizontal or loading position in Fig. 1. The heading illustration shows the position of the machine ram and of the pivot and hold-down arms at the end of the operation.

The downward movement of the jaws in a set-up of this type is controlled by the hold-down arms, which are attached to the pivot arms and anchored to the table of the press. At the start of the operation, a filler chain made up of fiber and aluminum links is inserted into the channel of the hat section to prevent the walls from collapsing.

Figs. 2 and 4 show an operation on a similar Boeing press in which the movement of the upper ends of the hold-down arms, which are attached to the jaw blocks, is controlled by cam

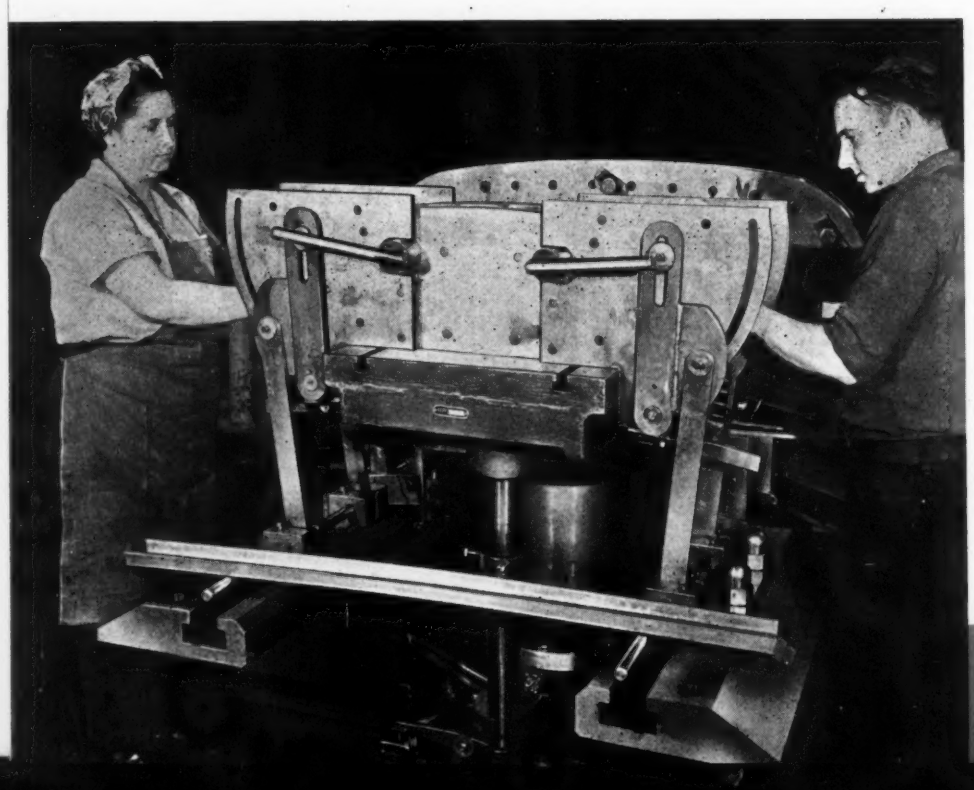


Fig. 13. An Operation in which Heavy Extruded Channel Sections are Stretch-formed through the Use of Both Cam and Lever Slots, which are Required by the Straight Lengths beyond the Curved Sections of the Work-piece

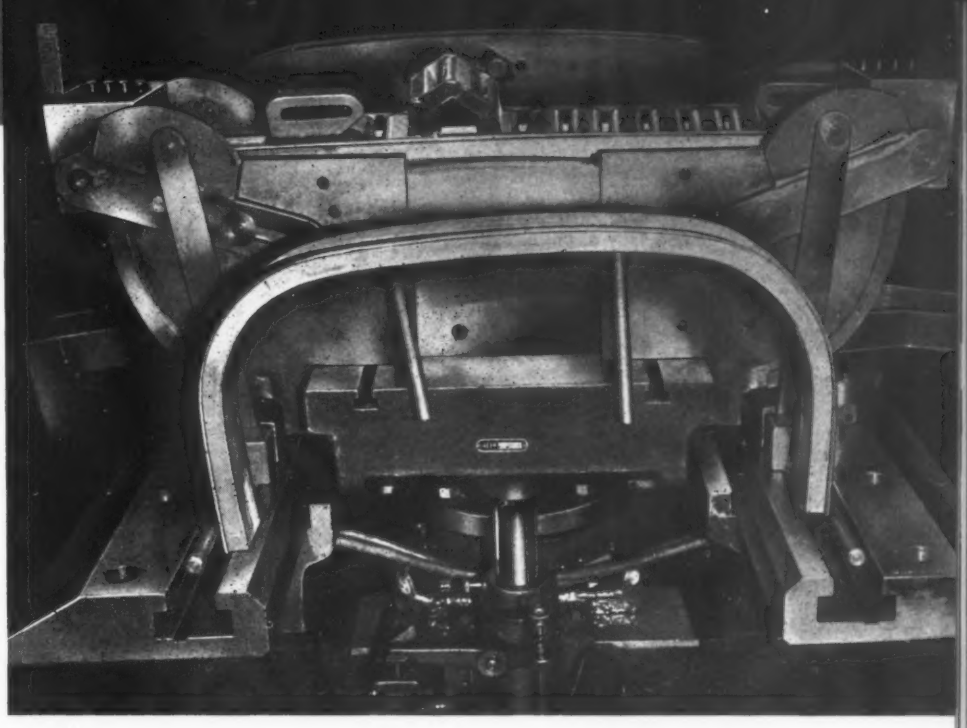


Fig. 14. Close-up View of the Stretching Equipment Provided on Machine Shown in Fig. 13. Completed Work-piece is Seen at Front of Machine

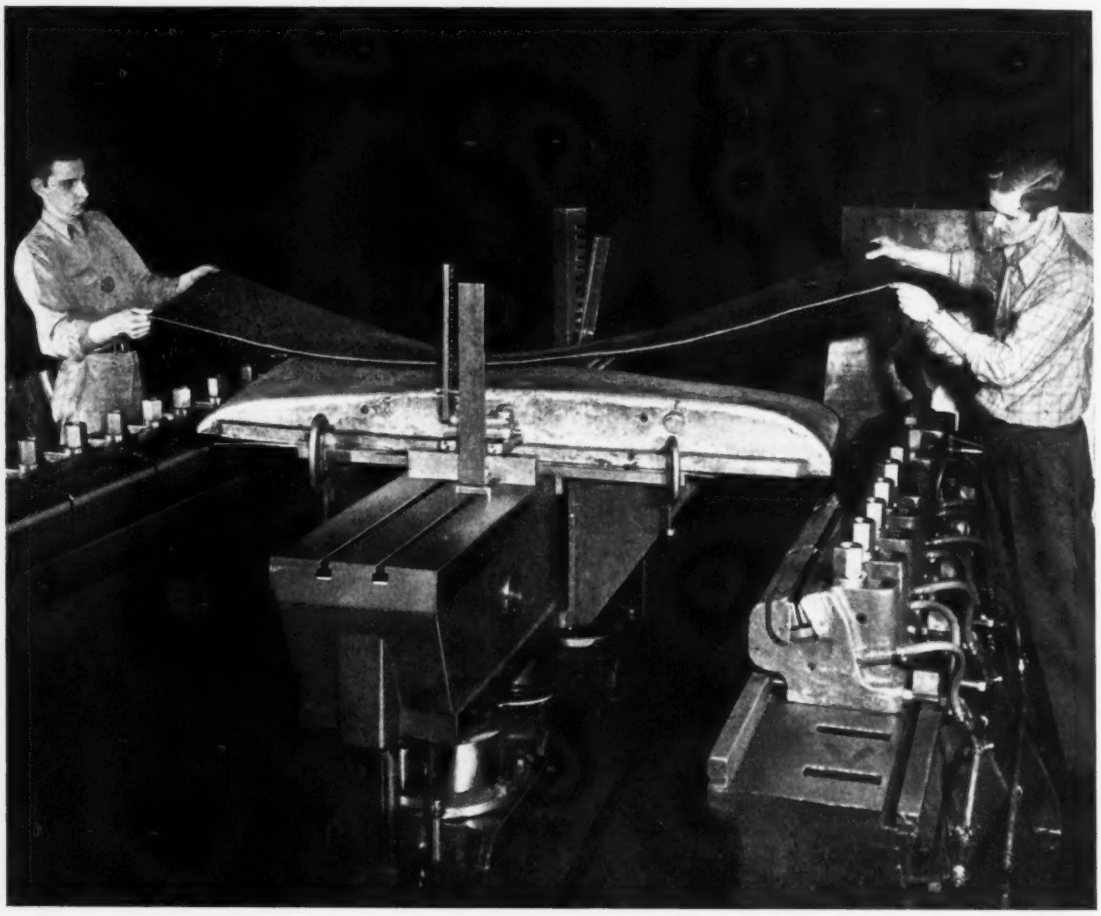
slots on the stretch-form. In Fig. 2, which indicates the position of the stretch-form at the beginning of the operation, the rollers of the hold-down arms are seen at the upper end of the cam slots. In Fig. 4, which shows the same machine at the end of the operation, the rollers of the hold-down arms are seen at the bottom of the cam slots. On the table of the machine may be seen examples of the hat section before and after the operation. The pieces are flap chords, and are formed with the flanges down.

An Erco 75-ton stretch press used for forming tank cradles from an extruded channel section is illustrated in Figs. 13 and 14. The channel section measures 3 3/8 inches across narrow flanges, is 1 1/4 inches deep, and is 1/8 inch thick throughout. In Fig. 14 may be seen the appearance of the section at the end of the operation. This is an instance where the long straight portions of the work-piece below the curves necessitate the use of a special combination of cam and lever movement.

In Fig. 14, the links and levers are seen in the positions they occupy at the beginning of an operation, while Fig. 13 shows the relative positions of the links and levers at the end of the operation. It will be seen that the links that are connected to the heavy jaws have a straight slot at one end. It is by means of this slot that the jaws can be held stationary for stretching the straight ends of the work-piece during the time that the press ram completes its upward stroke.

The front side of the stretch-block has a certain amount of lateral movement to facilitate loading of the work. After a section has been placed between the jaws and the aluminum-link filler chain inserted as illustrated in Fig. 3, clamps on the front of the stretch-block are tightened to force the moving member tightly against the channel section. When these clamps are loosened at the end of an operation, coil springs force the movable stretch-block forward away from the work. This heavy channel section is greased to facilitate the operation.

RUBBER SHEETING STRETCHING



How a Simple Ingenious Idea has Saved a Tremendous Amount of Production Time on Stretch-Block Work, Eliminated Hazards in Handling Stretched Skin Sections, Promoted Cleanliness, and Reduced Stretch-Block Costs. This Article Deals also with the Stretching of Extruded and Rolled Shapes

SPEEDS UP MARTIN OPERATIONS

By HARRY F. VOLLMER, Vice-President, Manufacturing
The Glenn L. Martin Co., Baltimore, Md.

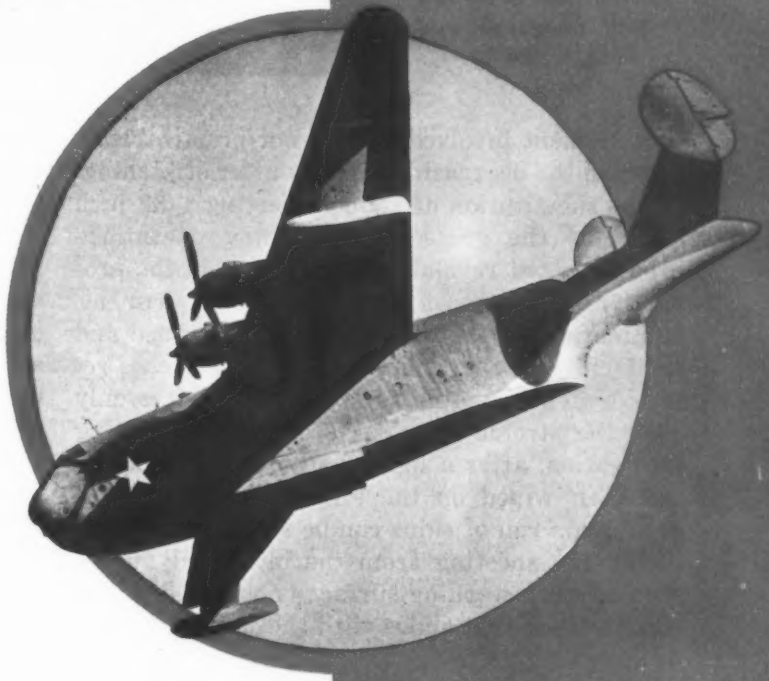
THIN rubber sheeting is now being used in factories of the Glenn L. Martin Co. as a substitute for the grease that is generally applied to the form or stretch-block in stretching operations on aircraft skins. The advantages derived from this unique application of rubber are manifold.

Grease is ordinarily applied to the stretch-block in generous quantities, so that the sheets of duralumin can slide readily on the blocks as they are being stretched. The application of the grease not only takes considerable time, but also entails a number of other operations in addition to those required in the actual working and machining of the skins. For example, it is necessary to scrape off the grease from the stretched work immediately after stretching. In the Martin plant, before the adoption of rubber sheeting, this was done by a group of employes equipped with rubber scrapers and wiping cloths.

After this partial cleaning, the work-pieces were transferred to scribing tables, where the actual outlines of the skin sections were marked with a scriber, ready for cutting away the excess portion or scrap by means of band saws. When the sawing had been completed, it was necessary to remove burrs from the edges of the skins by means of burring tools. The grease that remained on the skins after the preliminary cleaning left them slippery enough to make the scribing and sawing operations difficult and hazardous to fingers and hands. On that account, the workers had to wear heavy gloves and aprons to protect hands and clothing from being cut by the sharp metal edges.

The grease would rub off on the employes' clothing and drop on the floor, making walking difficult. Machines and tools in the department also became coated with grease and had to be cleaned up after each shift. It was the practice to scrape off the excess grease from machines and floors into pots and reclaim for future use, but this also involved additional operations.

After the skins had been sawed and burred, it was the practice to take them to a hot vapor-bath pit for complete removal of the grease. Because of the



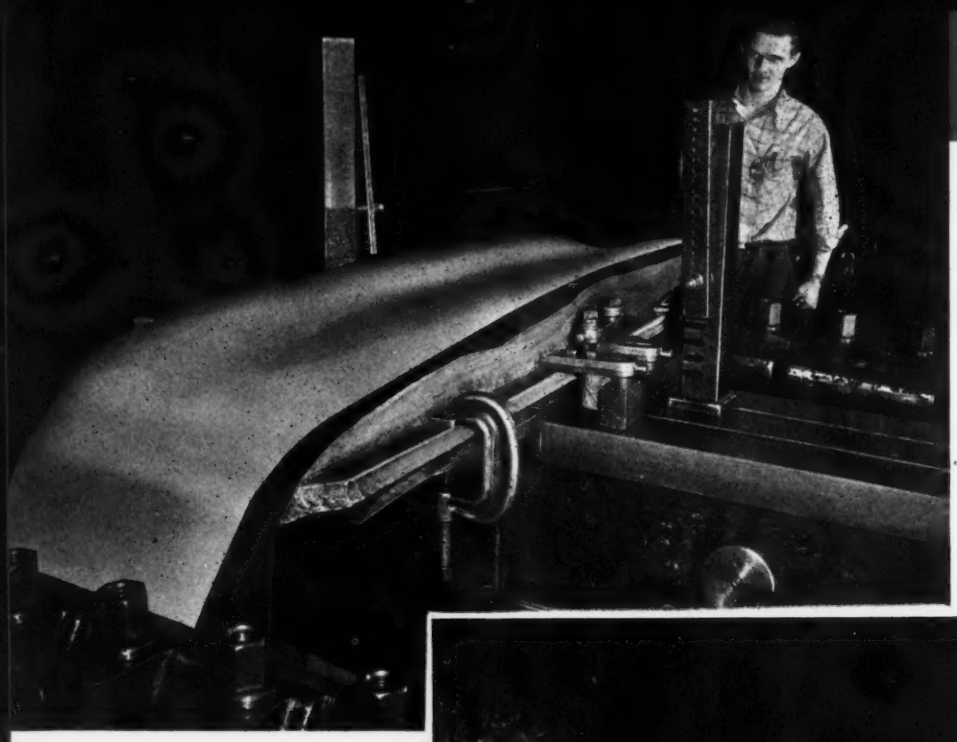


Fig. 1. The Use of Rubber Sheeting instead of Grease in Stretching Operations has Greatly Increased Production and Promoted Cleanliness

Fig. 2. Stretching Operation Performed with Rubber Sheeting, in which a Duralumin Skin is Curved both Crosswise and Lengthwise

time element involved, it was not practicable to perform the degreasing directly after stretching.

The substitution of rubber sheeting 1/32 inch thick for the grease in stretching operations brought about revolutionary changes in the production procedure of the stretching department, eliminating all the disadvantages of grease and the incidental operations required for grease removal. The sheeting is laid loosely but evenly over the stretch-block, as seen in the heading illustration, after a light coating of machine oil has been wiped on the stretch-block. Then a production run of skins can be stretched without lifting the sheeting from the block. By using the rubber, a working surface is obtained on the stretch-block that slides with the work.

When the new practice was first adopted, the rubber sheeting was clamped at the ends similar to the duralumin, but clamping was found unnecessary. It is important that there should be no wrinkles on the sheeting because any unevenness will show up on the work. Canvas and other materials have also been tried out in an attempt to use a less critical material than rubber, but an entirely satisfactory substitute has not yet been found.

Pits or other small defects on the stretch-block have no effect on the quality of the work because the rubber covers and compensates for such defects. It is not necessary either to polish the stretch-blocks to the high degree of smoothness that was essential to satisfactory stretching

SPEEDS STRETCHING

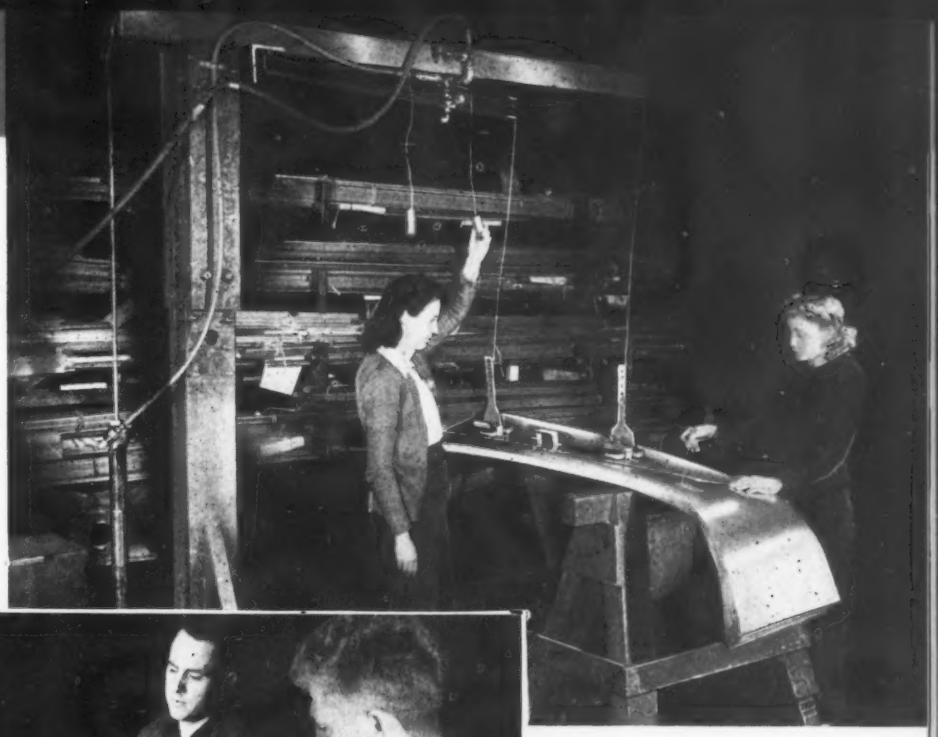


Fig. 3. The Provision of Air-operated Equipment for Handling the Templet has Greatly Speeded up the Scribing of Stretched Airplane Skins

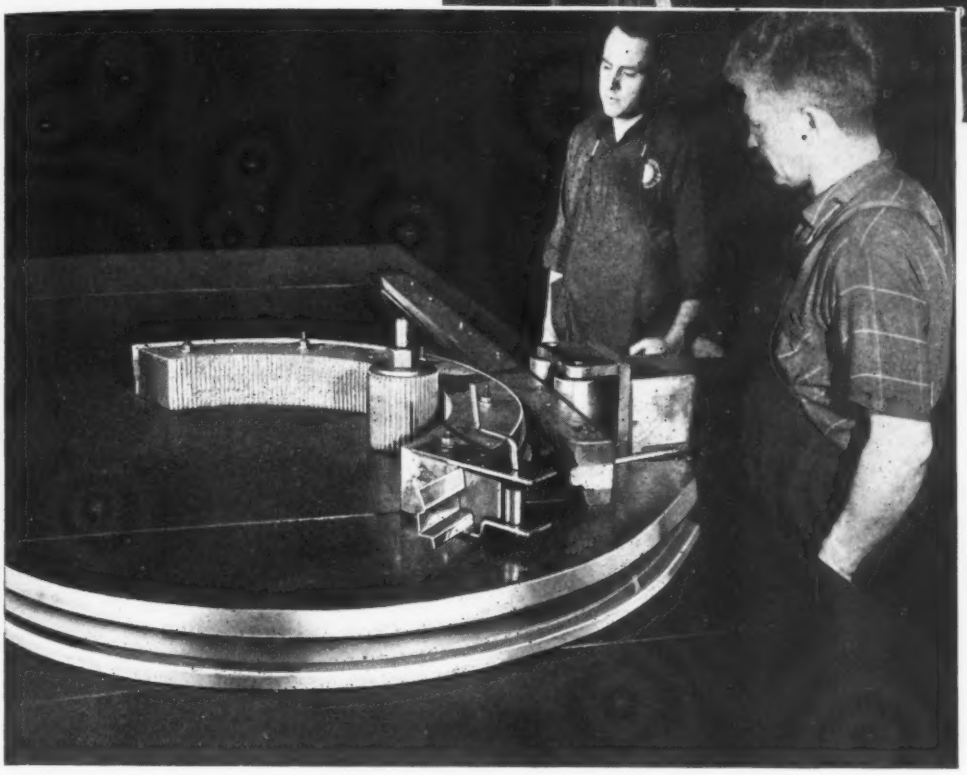


Fig. 4. Extruded and Rolled Shapes are Preformed as Shown and then Heat-treated before Stretching to Close Limits on Erco Machines

when grease was used as a lubricant. The new practice, therefore, saves substantially on the cost of stretch-blocks. The rubber sheeting comes in 48-inch widths and duralumin sheets up to this width can be handled. The Goodyear compound number for the sheeting is 27002-11, the compound ranging from 30 to 50 Durometer.

The greatest advantage of rubber sheeting is, however, the saving in time derived from its use. Two sheets of duraluminum can be stretched at one time on top of each other. This fact, together with the elimination of greasing, has tripled the production in skin stretching operations. In an operation such as shown in Fig. 1, the hourly production is now 150 skins, as against 175 skins per eight hours with the previous method. This operation consists of stretching wing and fuselage fillets to a reverse curve crosswise and also to a convex curve lengthwise. The reverse curve has a maximum depth of about 6 inches. The duralumin is 0.025 inch thick and comes to the machine in 24- by 72-inch sheets.

Added to the advantages of rubber sheeting already mentioned is the complete elimination of the degreasing expense, which should include the cost of an elaborate oven that was contemplated being used for melting the grease on the stretched skins. Handling of the work is now performed with far less hazard to the employes. It is not necessary now to clean machines and tools after each shift, and floors are not slippery.

Fig. 5. Close-up View of One of the Insert Holders as Set up for the Square Tube Stretching Operation Shown in Fig. 6. The Square Insert for the Inside of the Tube is Clearly Shown

All of the skin stretching operations are performed on 24 S-T (tempered) duralumin, which has been found easier to stretch than 24 S-O (annealed), the former material possessing greater strength. Stretching operations, except for the use of rubber sheeting, are performed in the conventional manner. The rubber sheets last for more than 10,000 pieces, finally becoming worn out as the result of creases developed by the edges of the stretch-blocks. Stretch-blocks are now designed with more generous edge radii to increase the life of the rubber sheets.

Another stretching operation performed with rubber sheeting is illustrated in Fig. 2. The rubber can be seen hanging down over the stretch-block along the right-hand edge of the duralumin sheet. This work-piece consists of cowling. It is stretched to curves both crosswise and lengthwise. Erco machines of 300-ton rating are used to perform this operation.

One of the important requirements for successful stretching is a solidly supported stretch-block with a perfectly flat bottom surface. If these conditions are not met, the block is likely to become distorted by the heavy force applied in stretching, with the result that the radii of the forming surfaces on the top of the block will be altered. When reverse curves are being formed on work, grease is sometimes applied to the stretch-block to make the rubber adhere better but, of course, the work does not come in contact with the grease in such instances.

Successful stretching depends to some extent on the carefulness and experience of the machine operator. He usually starts stretching one side of the work-piece and gradually stretches the material toward the opposite side. Another important consideration is the relation between the duralumin sheet clamping jaws and the stretch-block. The design of the flat developed sheets, too, must be the result of considerable experience.

Fig. 6. (Left) Stretching Square Tubing to Required Contour within a Few Thousandths Inch after Preforming and Heat-treating

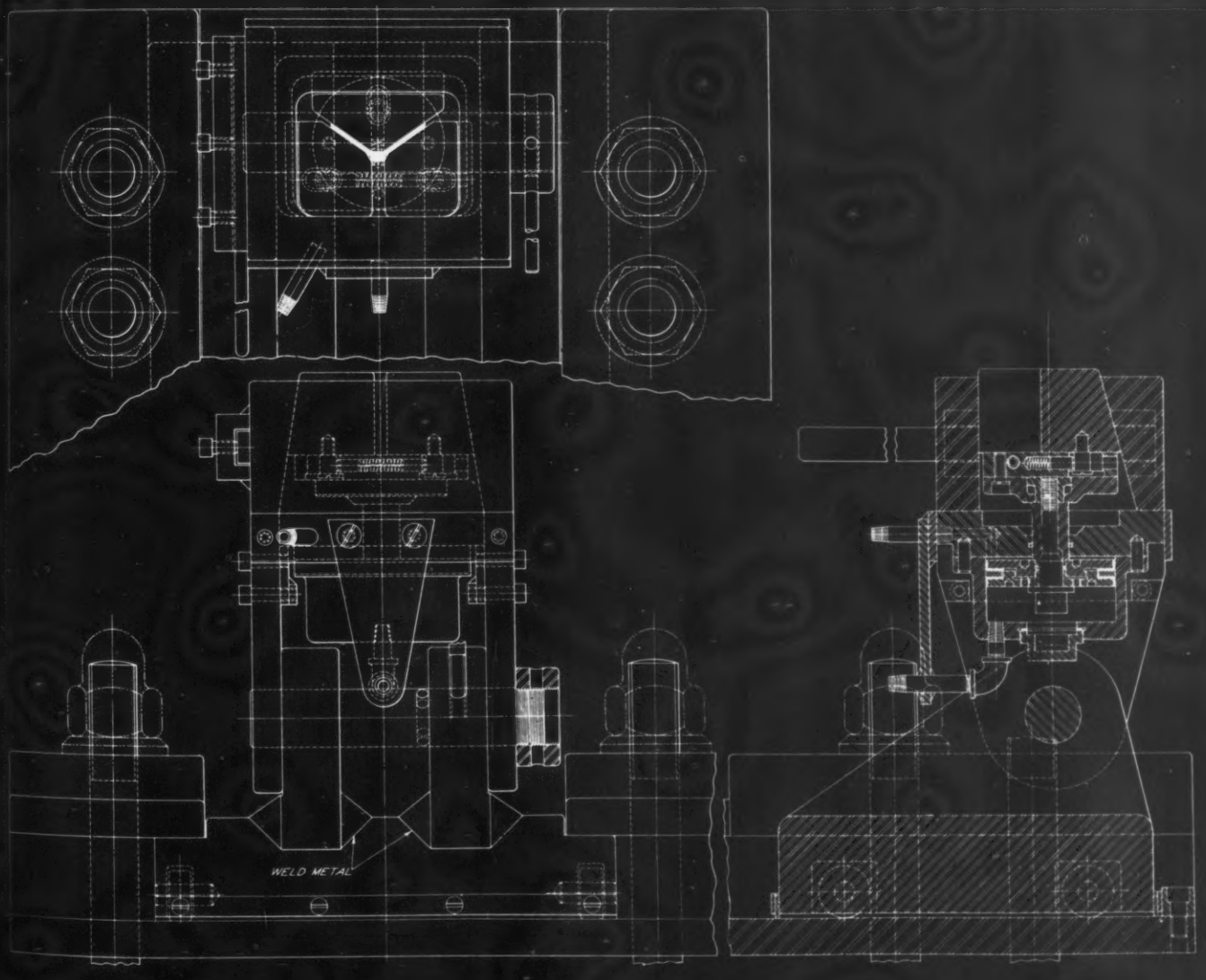
Fig. 7. (Right) Construction Drawing of an Insert Holder Such as Employed in Shape Stretching and Straightening Operations

In the cases of reverse curvature, it is essential that the stretch-blocks be so designed as to permit the proper rate of metal flow in the critical areas. During the set-up the operator can tell when the duralumin has been stretched just beyond its elastic limit, and stops are set to govern the production run. Pressure is then released and the work-pieces removed.

Ordinarily, the stretched sheets are not scribed until all the sheets of a lot have been produced and the stretch-block has been removed from the machine. The stretch-block is then placed on wooden horses for convenience, and the work-pieces are laid carefully on its contours to insure accurate scribing. When the photograph shown in Fig. 3 was taken, however, the stretch-block was still in use in the machine. In this case, a solid support of the required contour was obtained for the work-pieces by stacking a number of skins on top of each other.

Scribing operations have been made easy by eliminating manual labor in handling the templet to which the outlines are scribed on the duralumin sheets. As seen in Fig. 3, the templet is suspended from steel cables which run over small pulleys on structural arms mounted horizontally on a vertical column. The opposite ends of the cables are connected to a piston-rod which extends from a small-diameter air cylinder at the rear of the column. When one of the girls pulls a handle, as seen in the illustration, air is admitted into the cylinder above the piston. The piston-rod is pulled down, drawing the cables with it, and the templet is raised several feet above the stack of work. When the air valve is closed by pulling the second handle, the templet drops down on the next work-piece to be scribed. This simple device has greatly reduced fatigue of the workers and speeded up the scribing operation. Whereas two girls scribed from 375 to 400 sheets in an eight-hour day when they handled the templet by hand, they now scribe from 975 to 1000 in the same time. The cylinder is 2 inches in diameter and provides a 37-inch piston stroke.

Erco stretching machines are also used ex-



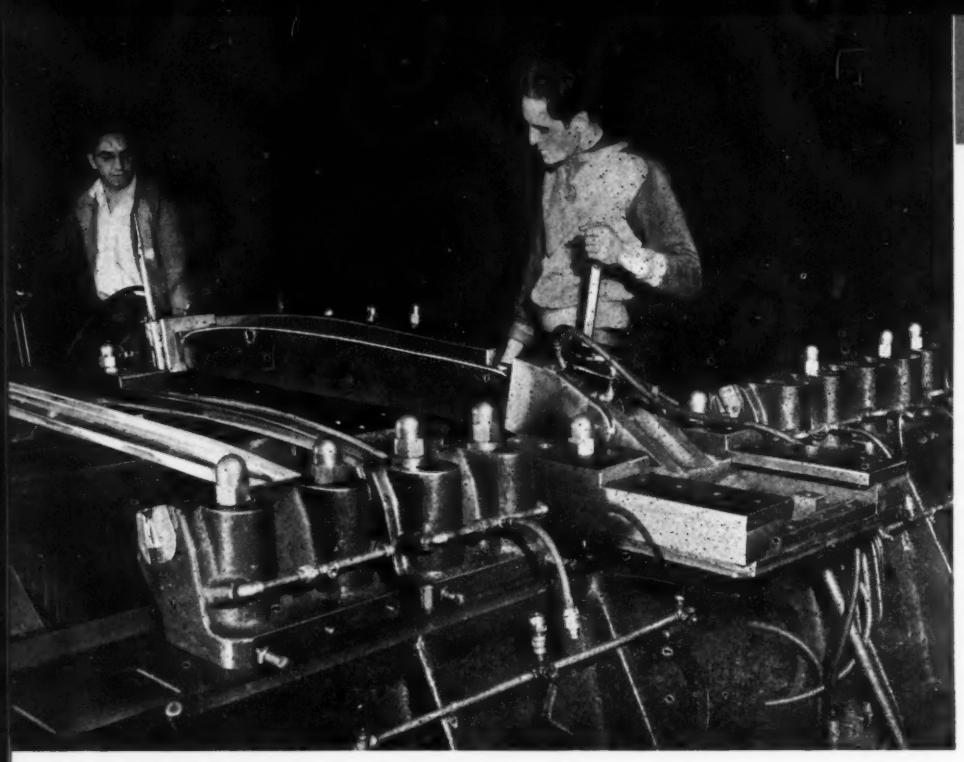


Fig. 8. Stretching Channel Shape to Required Contour, a Wooden Block being Placed in the Channel Trough to Prevent Contraction of Channel

tensively for stretching extruded and rolled aluminum shapes. Most of these are preformed to approximate radii on rolling benches, such as seen in Fig. 4, and then heat-treated before being brought to the Erco machines. Between heat-treating and stretching, the shapes are kept in refrigerators to prevent aging.

Square tubing, such as seen being stretched in Fig. 6, is preformed with a flexible mandrel made up of square washers inserted in the tubing to prevent collapse of the tubing walls. This mandrel is held in position opposite to pressure rolls by means of a long rod that extends completely through the tubing and is attached to the far end of the bench. The tubing is duralumin.

In the stretching operation on the square tubing after heat-treatment, the work-pieces are produced so accurately that they fit gage-blocks without any hand work. Tolerances as close as 0.010 inch can be maintained with ease. Each end of the tubing is gripped between jaws contained within swiveling blocks of the construction clearly seen in Fig. 5. Between the jaws is a square insert, over which the end of the tubing is slipped and which prevents collapse of the tubing end when the jaws are clamped on the outside walls of the tubing by air pressure. The air valves are operated by foot-pedals. When both ends have been clamped, the tubing is drawn over the stretch-block seen in Fig. 6 until the elastic limit has been passed.

These square-tubing work-pieces are being formed at a rate ten times greater than was previously possible by hand methods. The tubing

Fig. 9. (Left) Operation in which a Stepped Piece of Duralumin 0.025 Inch Thick is being Stretched. Wrinkles in the Work are Prevented by Clamping a Duralumin Bar on the Shape

Fig. 10. (Right) Shape-straightening Machine with a Headstock Slide that is Actuated by a Pneumatic-hydraulic Cylinder of Large Diameter

measures 1 1/4 inches square outside, and has walls 0.064 inch thick.

Jaw blocks of the type used in this operation are employed in all stretching of extruded and bent up shapes. In each case, of course, the jaws and inserts are designed specifically for the particular shape being stretched. The construction of a block and jaws for a V-shaped section is shown in detail in Fig. 7. It will be obvious that the jaws are closed on the work-piece by sliding along wedge-shaped surfaces when they are raised by the action of the pneumatic cylinder.

Another stretching operation on a rolled piece of channel cross-section is shown in Fig. 8. This piece is stretched to a large radius after heat-treatment. To prevent contraction of the channel during stretching, a wooden block with a tongue corresponding to the inside dimension of the channel is placed into the piece after it has been gripped by the jaws. Stretching is performed at ten times the rate when a hand method was used. Immediately after removal from the stretching machine, the channels are cut in half lengthwise.

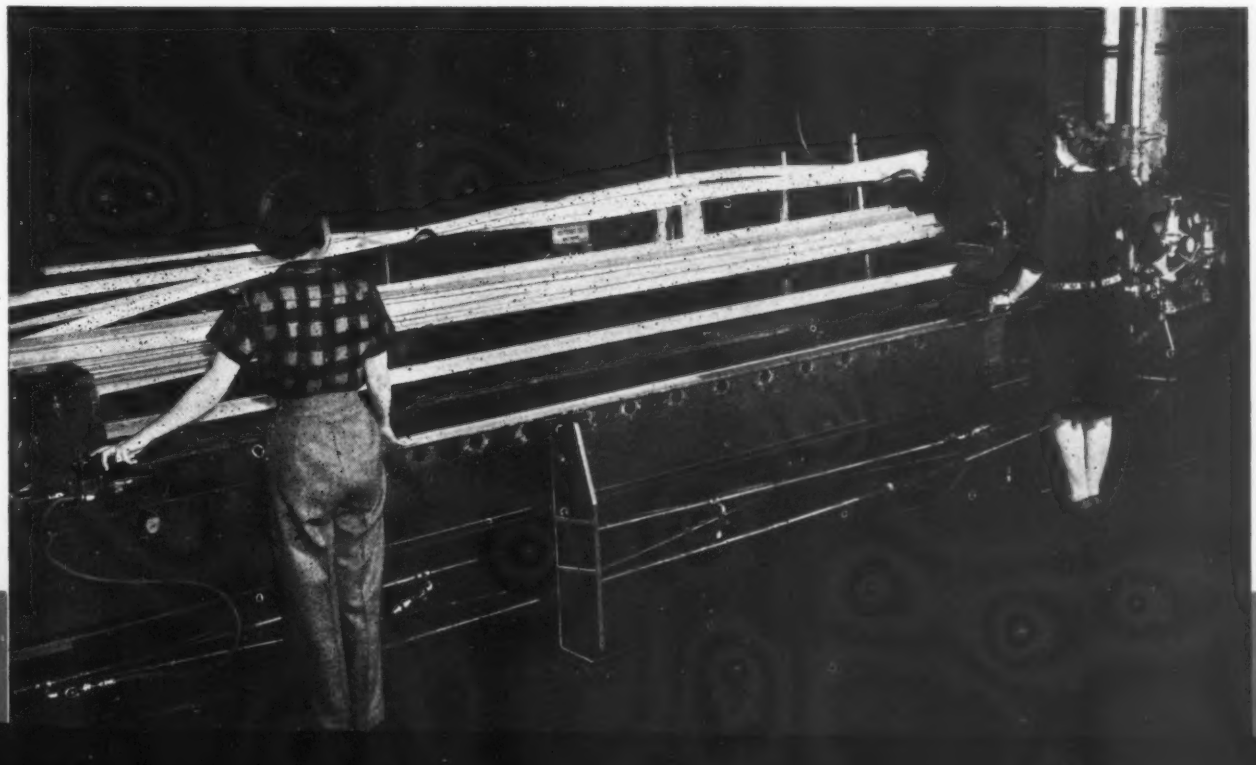
A Z-shaped section of duralumin only 0.025 inch thick is seen being stretched in Fig. 9 to a radius of about 6 inches near the center. This piece, too, is preformed and heat-treated prior to its arrival at the stretching machine. When it leaves the machine, it must fit a check block within 0.005 inch at every point. In this stretching operation, a duralumin bar, shaped along one edge to suit the cross-section of the strip, is clamped securely on the strip, as shown, to prevent buckling.

Straight lengths of extruded and rolled shapes that have warped in heat-treating are straightened in a special Martin-built machine that is shown in Fig. 10. The ends of the shape are gripped in jaws at both the headstock and tailstock ends of the equipment. The tailstock remains stationary during an operation. However, it is adjustable to various positions along the bed to suit different lengths of work.

The jaws of the headstock are mounted on a slide so that the headstock moves away from the tailstock for the stretching. The slide movement is obtained through a combined pneumatic-hydraulic action. An air valve is opened to build up pressure behind soluble oil in a cylinder located on the right-hand end of the bed. The supply of soluble oil is maintained by the vertical tank seen above the cylinder. The maximum piston stroke is 18 inches.

In order to stretch all pieces of a production lot the same amount, the machine is equipped with a scale on the bed and a pointer on the headstock slide. As the first piece of a lot is straightened, the operator observes the position of the pointer along the scale. Subsequent pieces are stretched the same amount. The jaw blocks or holders are of the same construction as those provided for shapes on the Erco machines.

The air valve that controls pneumatic pressure on the slide cylinder is actuated by a long handle, and the headstock jaws are opened and closed by air as the operator steps on or releases a foot-pedal. This leaves one hand free to hold the end of the stock between the jaws until they are gripped on the work. The tailstock jaws are controlled by a hand-operated air valve. This machine also has effected large economies.



Milling Douglas Spar Caps from

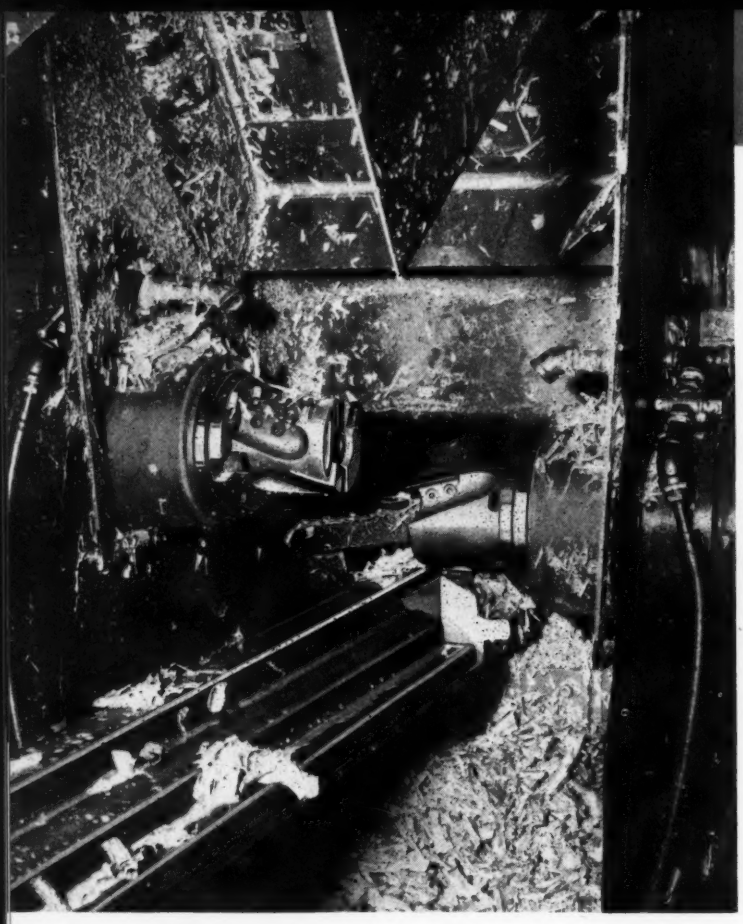
The Manufacturing Technique Established for Producing Two Spar Caps of Unique Design from One Aluminum Billet 30 Feet in Length

By N. A. LOMBARD, Superintendent of Tooling
and G. R. GWYNNE, Project Co-ordinator
Spar Cap Tool and Machine Engineering Group
Tooling Division
Douglas Aircraft Co., Santa Monica, Calif.

Integral-Eye Rolled Billets

SPAR caps having a large integral eye at the inner end where the wing is joined to the airplane fuselage, are now being used in planes built by the Douglas Aircraft Co., Inc., Santa Monica, Calif. This radical innovation in spar cap construction greatly simplified assembly methods and resulted in large economies in manufacturing costs, but it necessitated the development of original manufacturing methods because of the fact that a large lug was required for the eye at one end of a long beam of comparatively slender cross-section. Extruded sections of aluminum alloy, then universally used in spar cap production, could not be utilized as the raw material in making spar caps of the new design, due to the mass of metal required and the length of the spar caps.

The manufacture of integral-eye spar caps was subsequently based on the use of hot-rolled billets of 14 S-T aluminum alloy and the principle of cutting two spar caps of right- and left-hand types from each billet. It should be borne in mind that this material was used only



as a forging stock prior to this application—never as a raw material from which spar caps were actually machined.

In the rough form, each spar cap is of approximately uniform cross-section for its entire length, except for the integral-eye lug at one end. How this lug is formed and how the spar caps are rough-machined, then split apart and finish-machined, will be here described. The manufacturing procedure set up in the original Douglas spar cap plant, which is now being followed in several other factories, will be dealt with.

When the hot-rolled billets of aluminum alloy reach the spar cap plant, they average 30 feet in length and approximately 29 square inches in cross-section, the latter being of the shape seen in Fig. 2. Each billet weighs 1000 pounds. Each finished spar cap weighs close to 185 pounds, the two caps produced from a billet having, therefore, a total weight of 370 pounds. This means that 630 pounds of chips are removed from each billet so that 63 per cent of the metal in the original billet goes into chips. From billets of this type are cut the eight spar caps which constitute the structural beams that carry the wing load of each plane.

In the development of the manufacturing process, the major problem that had to be solved was the splitting of two spar caps from each billet. The split had to be made about 28 feet in length and through an average thickness of 5 inches. In the original tests, unrelieved stresses caused failure of the spar caps as the attempt was made to split them. Finally, a sound principle was arrived at, which made the entire manufacturing program feasible.

From the raw stock piles in the storage yard, the billets are taken to a sawing machine, where they are cut to length to suit the type of spar caps that is to be produced. Then the billets go to a large Ingersoll milling machine of special design. Close-up views of this machine are seen in Figs. 1 and 4. This machine is built with a bed over 30 feet in length, on which the rough billet is clamped, and it has a large housing which spans the bed and is movable on tracks that extend the full length of the bed. Two cut-

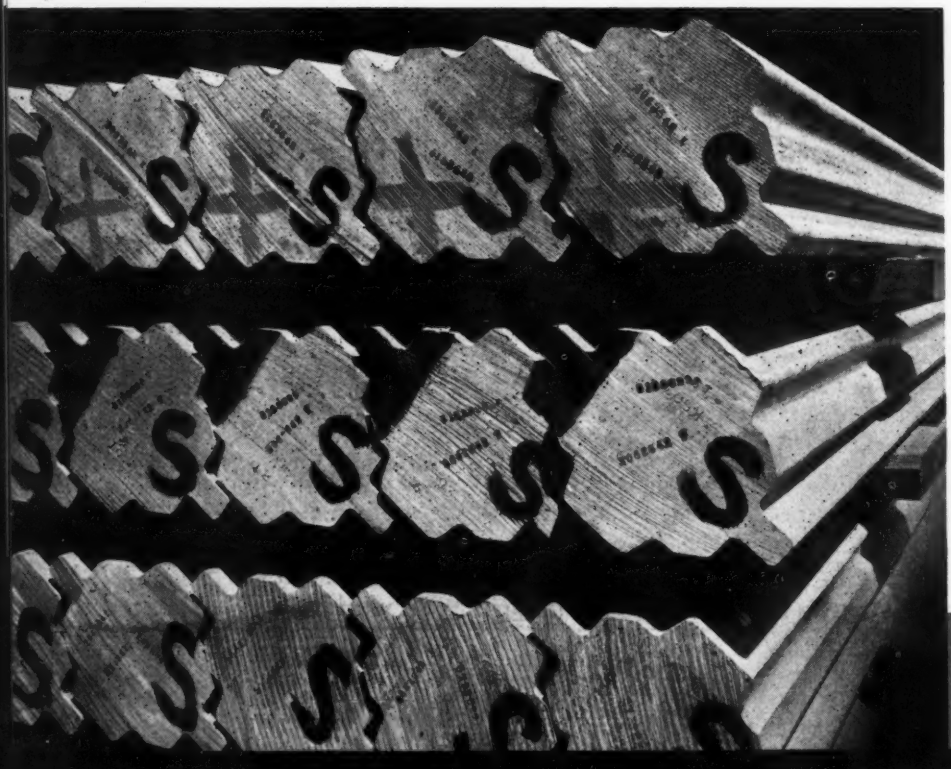


Fig. 1. (Above) Tool-entry Slots are Milled through Opposite Ends and on Opposite Sides of Aluminum Alloy Billets Such as Shown in Fig. 2, there being One Slot at Each End

Fig. 2. (Left) Billets of Hot-rolled 14 S-T Aluminum Alloy, 30 Feet in Length, from Each of which Two Integral-eye Spar Caps are Milled

ter-heads driven by 12 1/2-H.P. motors are mounted on opposite sides of the housing for milling slots 4 1/2 inches wide completely down each side of the billet and as deep as the line along which the billet will later be split. The billet is tilted on the table fixture at the angle to which the split is to be made.

One slot is milled at one end of the billet and a second slot at the other end of the billet, on the opposite side. These slots provide for the entry and exit of cutters employed in subsequent operations for machining the major portion of the spar caps, with the exception of the integral-eye lugs. By means of these slots, the cutters can be entered into the work or withdrawn from it without coming into contact with the lugs.

Each slot is completed in two passes of the cutter, the first cut being taken downward at a depth of 2 3/4 inches from the widest point of the billet cross-section, the cutter passing completely down the side of the billet; the second cut is taken to a depth of about 1 3/4 inches—to the splitting line—after the cutter-spindle has been fed forward into the work. The second cut is taken with the cutter fed upward.

The photograph shown in Fig. 1 was taken after the cutter on the right-hand side of the machine had finished milling a slot. Note the size of the chips taken by the four-blade carbide-tipped milling cutter, which runs at 2900 R.P.M. and is fed vertically for the operation at about 7 1/2 inches a minute. When the slot at one end of the billet is completed, the cutter-head housing or carriage is moved to the opposite end of the bed for milling the slot at that end of the billet. Soluble oil is used copiously in this milling operation.

At the same time that the two entry slots are being milled, a separate hydraulically fed unit is employed to drill a hole horizontally into the corresponding end of the billet for use in clamping the billet and spar caps in succeeding operations. Fig. 4 shows the drilling unit at the end of the billet where the tool-entry slot is milled on the left-hand side. The drill is accurately guided into the center of the billet, as will be seen, by a bushing in a fixture mounted on the

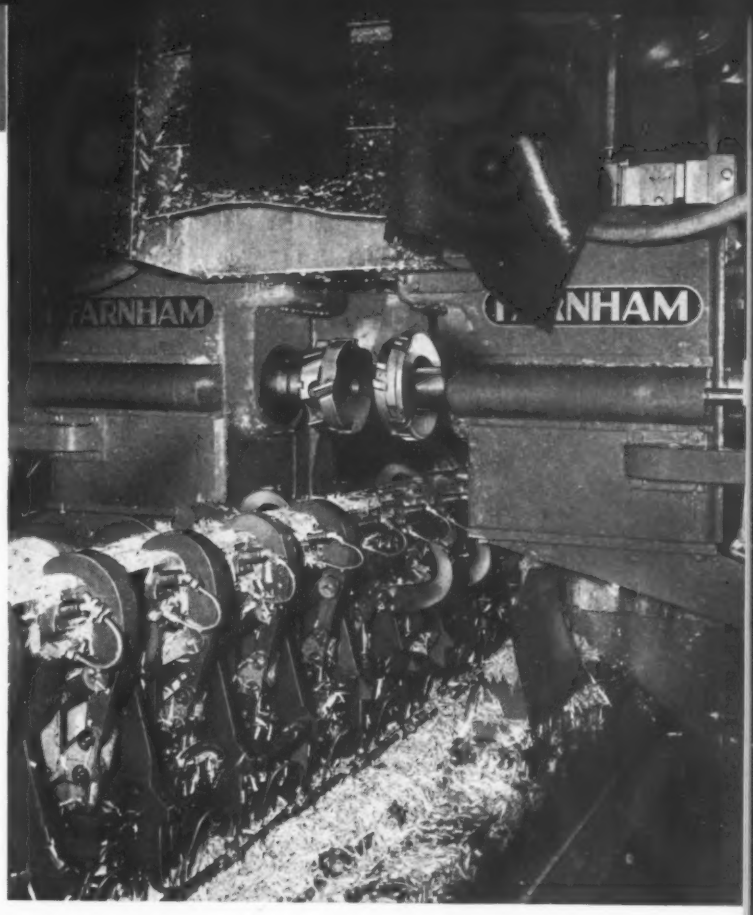


Fig. 3. (Above) The Major Portion of the Stock on the Billets is Cut away in Two Rough-milling Operations on Opposite Sides of the Billet, the First of which is Shown Here

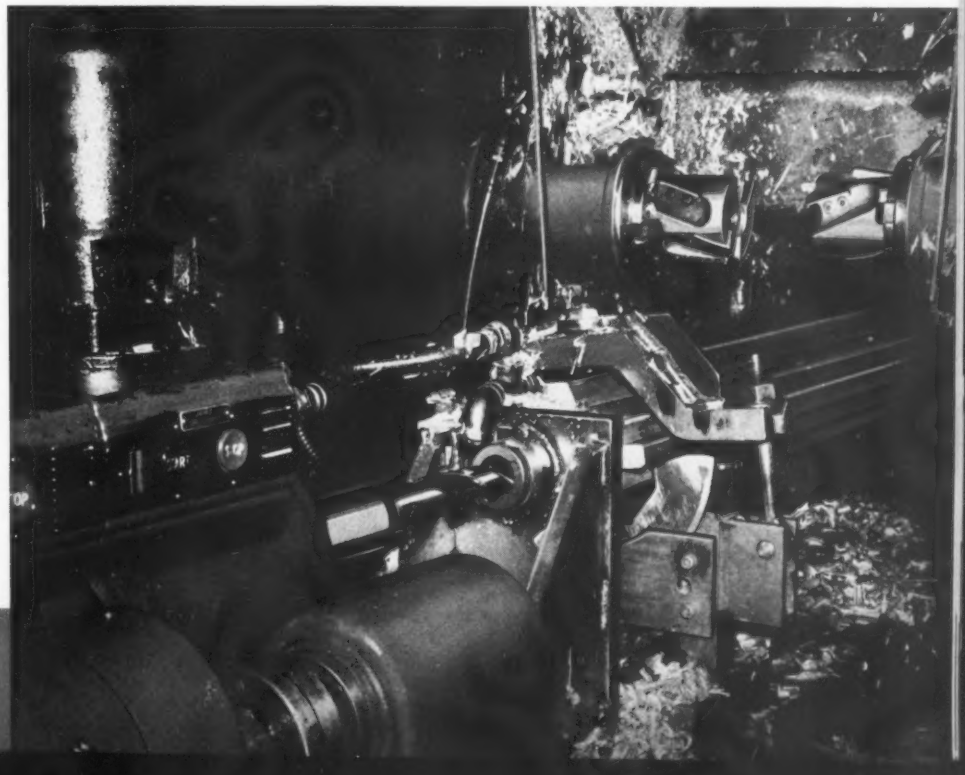


Fig. 4. (Right) While Tool-entry Slots are being Milled, a Hole Used for Clamping is Drilled in Same End of Billet in which Slot is being Cut

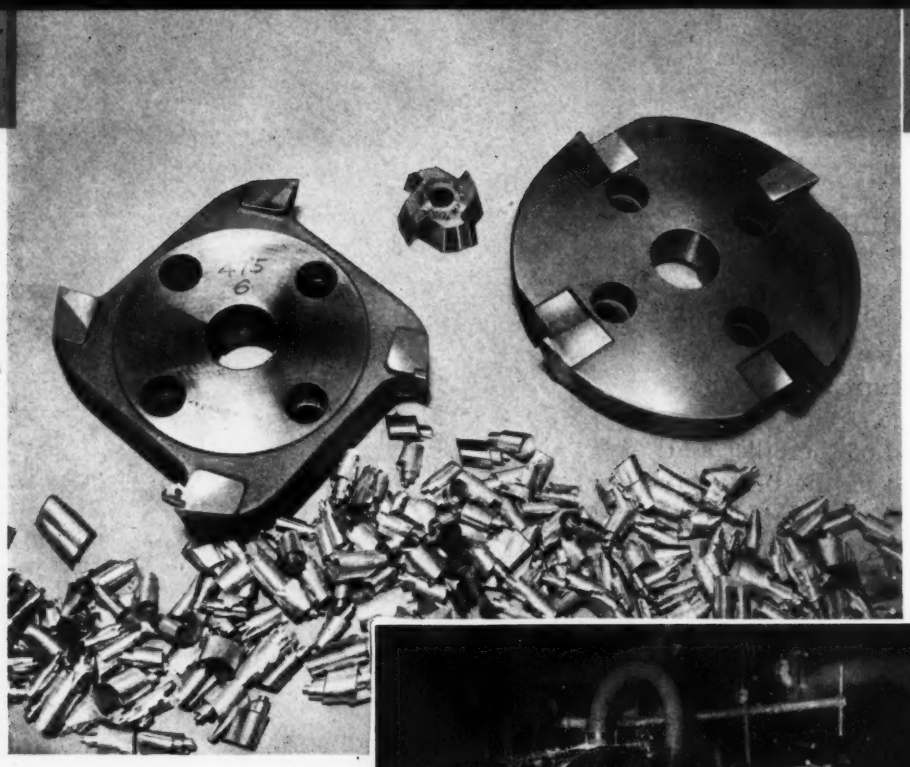


Fig. 5. Construction of Typical Solid and Inserted Carbide-tipped Cutters Used on Spar-cap Milling Machines

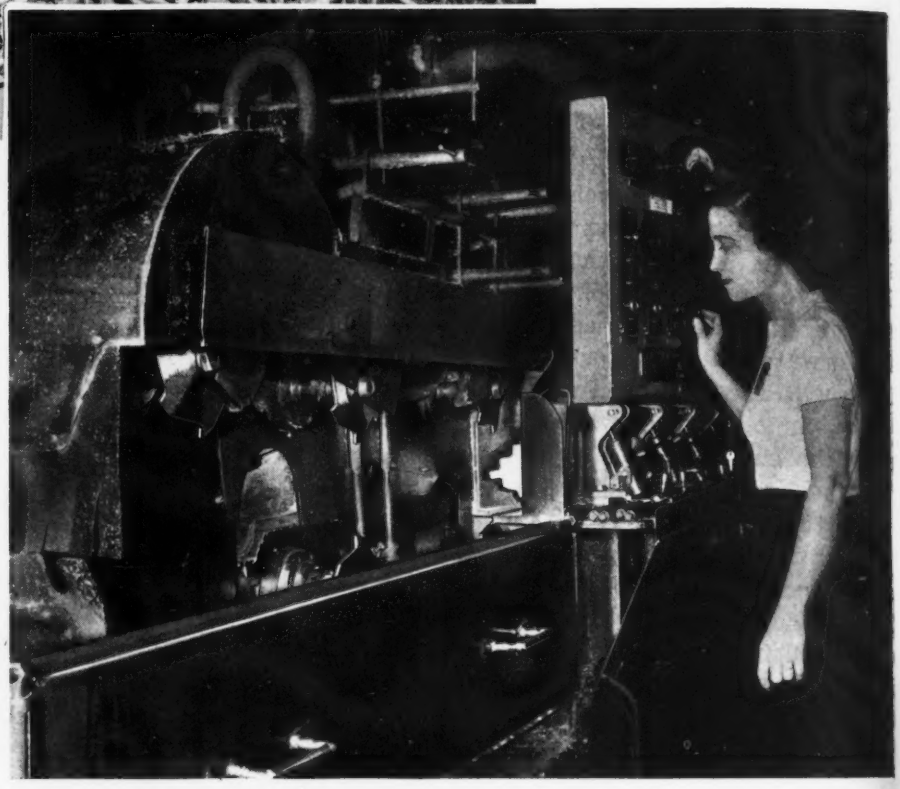


Fig. 6. Two Spar Caps are Split from Each Ingot on a Machine Provided with a Cutter-head Carriage on which Five Circular Slitting Saws are Mounted. The Billets are Split for a Length of 28 Feet in 5 1/2 Minutes

machine table. These holes are drilled to a diameter of 1 1/2 inches and to a depth of about 1 inch. One of the stops used for positioning the billet accurately at the splitting angle can be seen in the illustration.

The billets are next transferred to Farnham milling machines for rough-milling the major portion of the surplus stock from both sides. In originally planning for these rough-milling operations, a thorough study was made to insure that the cuts taken on the opposite sides of the work would balance each other and thus eliminate stress warpage. As a matter of fact, after the roughing cut has been taken on one side of the billet and the clamps that hold the billet to the machine fixture have been released, the billet bows 3 inches in its length. It is then turned upside down in a second machine for roughing the opposite side, and is pulled straight in the machine fixture through the medium of hydraulic clamps. As the second roughing cut is taken, the stress strains are neutralized and the billet comes off the second rough-milling machine straight throughout its entire length within plus or minus 1/16 inch.

Fig. 3 shows a close-up view of the first rough-milling operation. This machine is also constructed with an overhead carriage or housing that is fed the full length of the long bed by means of a lead-screw that runs along the back of the bed. Four cutter-heads, driven by individual motors of 40 H.P. running at 3000 R.P.M.,

are mounted on the carriage, two on each side of the bed. These cutter-heads are provided with cutters 8 inches in diameter which are fitted with four tungsten-carbide tips each that range from 1 to 2 inches in length. These cutters are set to a positive rake of 5 degrees and a positive helix angle of 10 degrees. They are ground with a land 1/32 inch wide, a primary clearance of 5 degrees, and a secondary clearance of 15 degrees. They are run at a cutting speed of approximately 6300 surface feet per minute. The construction of the cutters used on the spar-cap millers can be seen in Fig. 5.

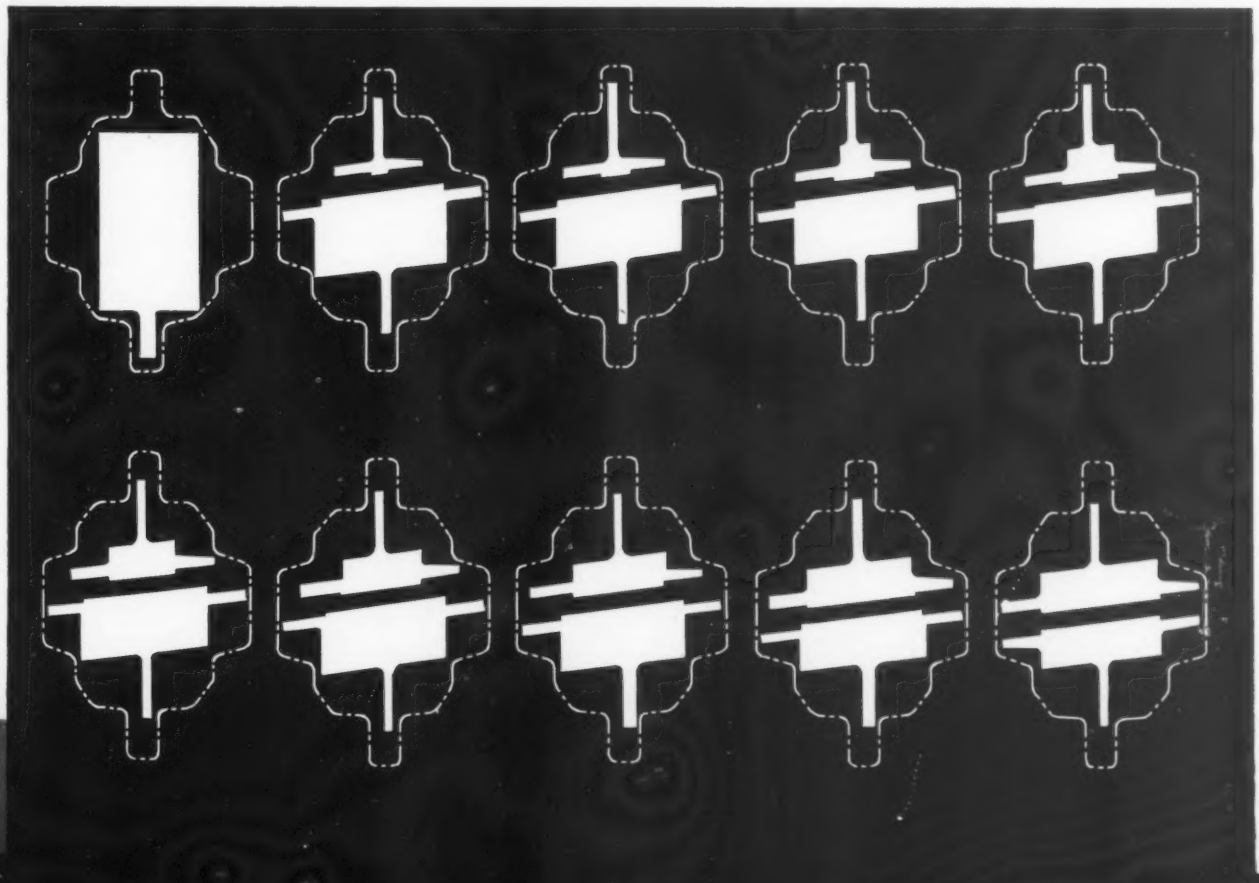
Arms extending downward from the cutter-heads are equipped with rollers that ride on templets mounted on the side of the bed. In this way, vertical movements are imparted to the cutters as the carriage travels along the bed to mill the top surface of the billet to the required changing profile. Stock is roughed off at the rate of 3 1/2 cubic inches per horsepower per minute, the carriage being fed along the bed at the rate of 70 inches a minute.

Eighty hydraulic clamps, forty on each side of the bed, hold the billet securely in the fixture for the operation. These clamps are automatically released as the cutters approach them and they drop away from the path of the cutters, as seen directly beneath the cutters in Fig. 3. When the cutters have passed by, the clamps are again automatically swung upward and pulled down on the billet to securely grip the latter until the operation is completed. Fig. 3 shows the cutters raised several inches above the work.

The hydraulic clamps are operated by trips on the carriage which come in contact with rollers on plungers that operate the hydraulic valves which control the clamp movements. Coolant is directed on the cutters and work through pipe jets with a force sufficient to wash the chips along the bed pan to an elevator at one end of the machine. Here the chips are carried to an overhead chute and dropped into a trough beneath the floor. The flow of coolant in this trough is strong enough to carry all chips to a conveyor that leads to a chip crusher and oil reclaiming unit located outdoors.

The second rough-milling operation on the billet is performed by a machine set up similarly to the one used in the first milling operation, but fitted with a fixture which is designed to receive the previously rough-milled side of the billet. The amount of stock removed in these rough-milling operations is clearly indicated in Fig. 7,

Fig. 7. Cross-sectional Views Taken at Different Points along an Integral-eye Spar Cap to Indicate both the Final Shape of the Spar Cap in Each Location and also the Area of Stock Removed in the Various Milling Operations



which shows cross-sections taken at different points along a spar cap. The first diagram at the left in the upper row shows a cross-section through the integral eye of one spar cap cut from a rolled billet. The remaining diagrams show, progressively, cross-sections through both spar caps produced from a billet. By following the bottom cross-section in each diagram, from the one at the left in the upper row to the one at the extreme right in the lower row, and observing the upper cross-section of the diagrams in the reverse order, an understanding will be obtained of the changing cross-section of a spar cap through its entire length.

The spar caps are split from the billet in an operation that follows the second rough-milling. This operation is performed on a Farnham milling machine having a cutter-head carriage equipped with five circular slitting saws, as illustrated in Fig. 6. These saws are arranged on horizontal cutter-heads in two rows, there being three cutter-heads in the upper row and two in the bottom row. Again the billet is held at a slight angle in a fixture mounted on the bed of the machine, so that the split will occur in the required angular plane. The billet is held firmly to the fixture in this operation by means of hydraulic clamps, which are arranged along one side of the fixture only, the opposite side of the billet being completely free of clamps.

The cutter-head carriage is seen in Fig. 6 at the starting end of the machine. When the carriage has advanced to a point where the first pair of slitting saws (one in the top row and the other in the bottom) are directly in line with the tool-entry slot at the same end of the billet, these saws are moved toward each other for cutting to a depth of about 1 1/2 inches into both the top and bottom of the billet as the carriage feeds along the bed. The cutters are 1/4 inch wide.

When the second pair of cutters reach the tool-entry slot, they also feed toward each other to cut slots to a depth that leaves only a 1/2-inch thickness of uncut metal in the center of the billet. The second pair of cutters are 7/32 inch wide. The fifth cutter drops into the entry slot far enough to cut through the remaining 1/2 inch of metal in the center of the billet and thus complete the splitting of the billet into two spar caps. This slitting saw is 3/16 inch wide.

When all the slitting saws reach the tool-entry slot at the opposite end of the billet, they are again raised to their starting heights, so as to clear the integral-eye lug at that end of the billet.

As the fifth and final slitting saw cuts through the billet, the spar cap on the side of the fixture

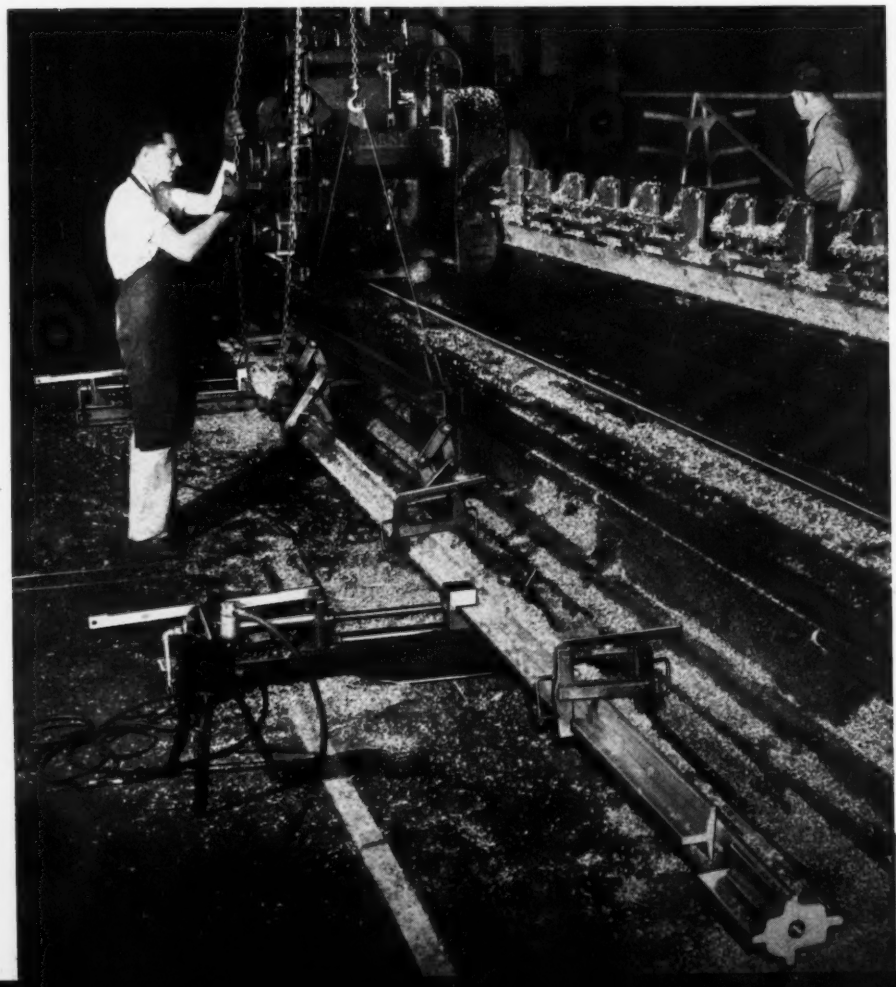


Fig. 8. General View of the Spar Cap Slitting Machine and the Hydraulic Jacks on the Floor in Back of This Machine which are Required to Remove the Hand Clamps from the Split Caps

Fig. 9. One of a Number of 75-ton Hydraulic Presses that are Employed to Straighten the Spar Caps between Various Milling Operations, the Spar Caps being Bowed as Much as 8 Inches after They Come from One of the Milling Machines

Fig. 10. As the Slitting Saw Carriage Proceeds along the Billet, Hand-operated Clamps are Applied for Attaching the Severed Spar Cap to the Spar Cap that Continues to be Held to the Machine Fixture by Means of Hydraulic Clamps

opposite the clamps would be unsupported and would hang from the fixture unless means were provided for attaching it to the clamped spar cap. This is accomplished by applying strong hand-tightened clamps, as seen in Fig. 10, at various points along the spar caps after the slitting carriage has passed by. These clamps serve a double purpose by also preventing the stresses that are relieved in the spar caps when they are split apart from warping the work-pieces until after they are unloaded together from the machine. The time required for splitting the spar caps the full length of 28 feet is less than six minutes, the carriage being fed at the rate of 60 inches a minute.

Hundreds of billets have been split by this method with complete satisfaction. The cutter-spindles are driven by 10-H.P. motors running at 3000 R.P.M. The saws are 9 inches in diameter, and are each provided with six tungsten-carbide cutters. The tungsten-carbide blades have a positive rake of 7 degrees, but are set to

Fig. 11. Close-up View of One of the Finish-milling Operations, with the Machine Stationary and the Guards Opened up, Showing Two of the Five Cutter-heads and the Hydraulic Clamps

a helix angle of zero degrees. They are ground with a 1/32-inch land, and have a primary clearance of 5 degrees, a secondary clearance of 12 degrees, and a side clearance of 2 degrees. The cutters are driven at a speed of 6800 surface feet per minute.

When the split spar caps are unloaded from the machine as one unit, while still held together by the hand clamps, the internal stresses tending to bow the spar caps exert such a pressure on the hand clamps that it is impossible to remove them unaided. For this purpose, the spar caps are lowered by a hand hoist to two hydraulic jacks arranged horizontally on the floor at the back of the slitting machine, as seen in Fig. 8. By means of these devices, sufficient pressure can be placed on the spar caps to overcome their tendency to bow or bend and the hand clamps can be taken off. When the hydraulic jacks are opened up, the spar caps will warp as much as 8 inches on a chord extending along the split side.

Right- and left-hand spar caps have now been produced from one billet. They are next lifted to the table of a Lake Erie 75-ton hydraulic press, as seen in Fig. 9, and accurately straightened. The spar caps are then transferred to Farnham milling machines similar to those used for rough-milling, but provided with five horizontal cutter-heads for performing 80 per cent of the finishing required. In this operation, the breeze side of the spar caps along which the datum line extends is brought to finished dimensions within plus or minus 0.010 inch. Profile

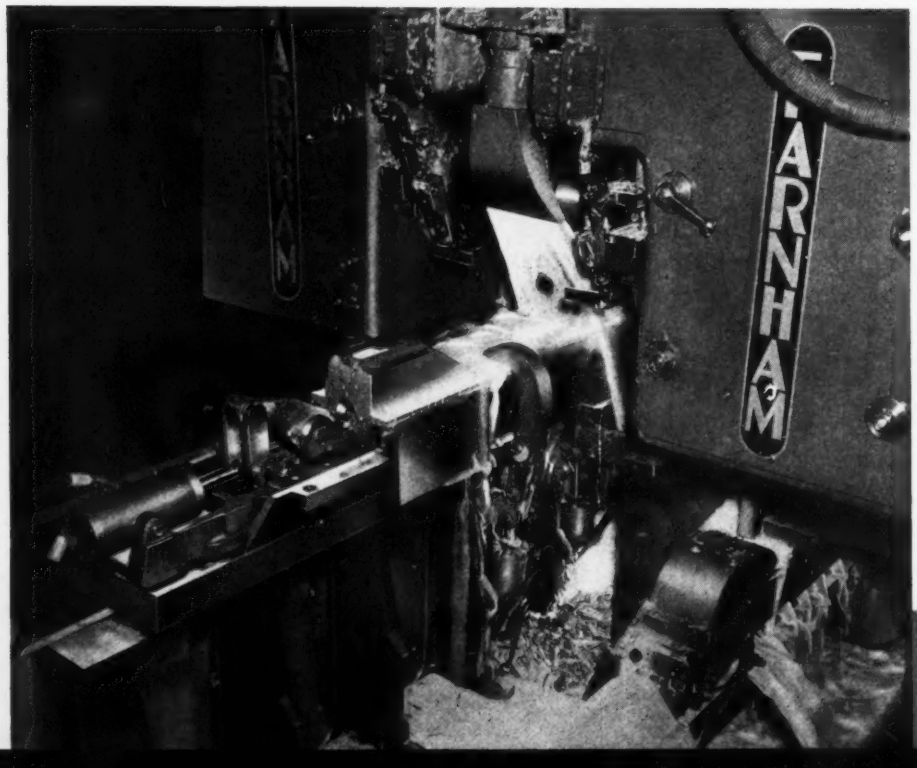


Fig. 12. Finish-milling Operation from Opposite Side of Carriage to that Seen in Fig. 11, Showing Clamp Used to Hold down Integral-eye Lug by Means of Hole Drilled in End

Fig. 13. Bending the Integral-eye Lug of a Spar Cap downward Accurately to Required Angle on a 400-ton Hydraulic Press while Operator Watches Graduations on a Moving Scale

templets mounted along the bed cause the rear heads to move up and down and the front heads to move in and out and up and down so that the spar cap surfaces are milled to the required contours and angles in all directions.

The spindles of this machine are equipped with cutters of the same type and size as the rough-milling machine. The tungsten-carbide blades are from 1 1/2 to 2 inches in length. They are ground to a positive rake of 5 degrees, and are set to a negative helix angle of 10 degrees. The primary clearance is 5 degrees, the secondary clearance, 15 degrees, and the land is 1/32 inch in width. The spindle speed is 3000 R.P.M., giving a cutter speed of about 6300 feet per minute. The carriage feed is 70 inches a minute.

Figs. 11 and 12 show one of the finish-milling operations. This machine is also equipped with hydraulically actuated flying clamps for holding the spar cap along its length. Fig. 12 shows the type of clamp that is used to hold down the integral-eye lug in both rough- and finish-milling operations by means of the hole drilled in the ends of each billet in the operation in which the tool-entry slots were milled.

Upon the completion of the first finish-milling operation, the spar caps undergo a second finish-milling performed by another Farnham machine, exactly like the one just described, provided with five cutter-heads. The cutters mill along the webs on the body side of the spar caps. When this operation is completed, the spar caps are finished, except for the integral-eye end. In this case, also, the spar caps have a bow of 8

Fig. 14. Milling the Profile of the Integral-eye Lug of a Spar Cap by Means of Two Cutters Mounted on a Column that can be Given Combined Longitudinal and Circular Movements

PREVIOUS SPAR CAP CONSTRUCTION

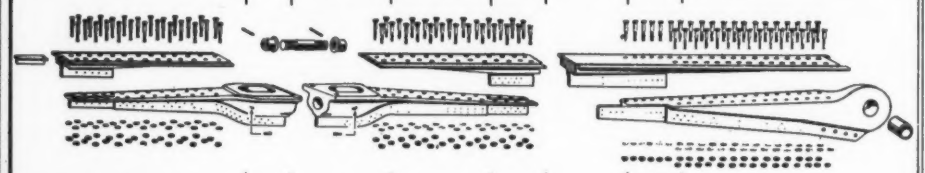
TOTAL LENGTH = 337 IN.

INTEGRAL-EYE SPAR CAP CONSTRUCTION

TOTAL LENGTH = 384 IN.

PREVIOUS SPAR CAP COST DATA

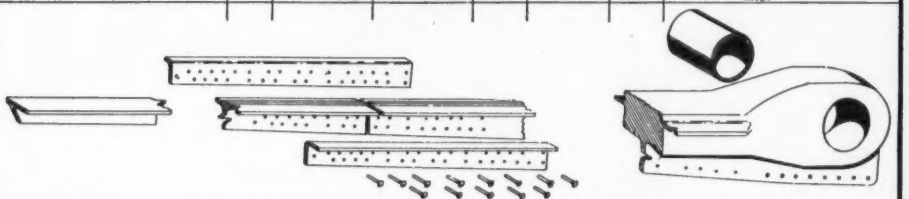
RAW MATERIAL	PARTS PER CAP	RAW MATERIAL COST PER CAP	VALUE OF SALVAGE MATERIAL PER CAP	NET COST OF MAT'L PER CAP	MACHINING COST PER CAP	TOTAL COST PER CAP	FINISHED PART
5063866 ALUM AL. EXTRUSION	1	16400 IN. LENGTH 102.9 LBS. @ $.048/LB = $49.40	38.54 LBS. @ $.11/LB = $4.00	64.46 LBS. $45.40	$18.90	$64.30	5063866 CAP - INB'D UPPER
5064410 ALUM AL. EXTRUSION	1	165.08 IN. LENGTH 73.8 LBS. @ $.048/LB = $35.40	58.50 LBS. @ $.11/LB = $6.40	15.30 LBS. $29.00	$12.92	$41.92	5064410 CAP - OUTB'D UPPER
5063328 ALUM AL. FORGING	1	22.96 LBS. = $28.05	9.18 LBS. @ $.11/LB = $1.01	13.78 LBS. $27.04	$10.15	$37.19	5063328 FITTING - INNER WING INB'D
5063405 ALUM AL. FORGING	1	23.07 LBS. = $16.84	13.87 LBS. @ $.11/LB = $1.53	9.20 LBS. $15.31	$11.90	$27.21	5063403 FITTING - INNER WING OUTB'D
5063362 ALUM AL. FORGING	1	23.07 LBS. = $16.84	13.05 LBS. @ $.11/LB = $1.65	10.02 LBS. $15.19	$12.92	$28.11	5063405 FITTING - OUTER WING INB'D
5/8 DIA. NICKEL STEEL BAR	87	24.58 LBS. 180.80 IN. @ $.272/FT = $5.34	1.54 LBS. @ $.006/LBS = $0.11	6.04 LBS. $5.23	$10.57	$15.80	1048606 DRIVE BOLT
AC 364-624	87	0.784 LB. 87 NUTS @ $.034 = $2.96	0.00 LBS. $0.00	0.784 LB. $2.96	$0.00	$2.96	AC 364-624 STOP NUT
AN 960-616	87	0.392 LB. 87 WASHERS @ $.0008 = $0.09	0.00 LBS. $0.00	0.392 LB. $0.09	$0.00	$0.09	AN 960-616 WASHER
1 5/8 DIA. X 4150 C.M. STEEL BAR	1	3.645 LBS. 6.875 IN. @ $.069/FT = $0.36	0.26 LB. @ $.006/LBS = $0.00	3.39 LBS. $0.36	$5.60	$5.96	1066286 PIN-INB'D & OUTB'D WING ATT.
1 1/8 DIA. X 4140 C.M. STEEL BAR	2	6.62 LBS. 5.375 IN. @ $.175/FT = $0.70	4.80 LBS. @ $.006/LBS = $0.03	1.82 LB. $0.67	$7.00	$7.67	1066285 NUT-INB'D & OUTB'D WING ATT.
.064 X 4130 C.M. STEEL SHEET	2	0.46 LB. @ $.13/LB = $0.06	0.32 LB. @ $.005/LBS = $0.00	0.169 LB. $0.06	$0.03	$0.09	1160068 WASHER-INB'D & OUTB'D WING ATT.
.372 DIA. DRILL ROD	1	0.040 LB. 2.4375 IN. @ $.047/FT = $0.01	0.002 LB. @ $.006/LBS = $0.00	0.038 LB. $0.01	$0.35	$0.36	1145346 SAFETY PIN
1/4 DIA. ESH AL. BAR	2	.0088 LB. @ $.31/LB = $0.00	0.0036 LB. @ $.09/LBS = $0.00	0.006 LB. $0.00	$0.30	$0.30	1057286 SAFETY PIN
2 1/2 X 5/16 C.M. STEEL TUBE	1	1.266 LB. 2.300 IN. @ $1.85/FT = $0.39	0.581 LB. @ $.008/LBS = $0.00	0.719 LB. $0.39	$2.10	$2.49	1062977 BUSHING
ASSEMBLY COST						$32.90	
TOTALS →	275	283.51 POUNDS $156.44	57.21 POUNDS $14.73	226.30 LBS. $141.71	$92.74	$267.35	



TOTAL COST OF PREVIOUS SPAR CAP ASSEMBLY = $267.35
TOTAL WEIGHT OF PREVIOUS SPAR CAP ASSEMBLY = 126.30 LBS.
COST PER POUND OF PREVIOUS SPAR CAP ASSEMBLY = $ 2.12/LB.

INTEGRAL-EYE SPAR CAP COST DATA

RAW MATERIAL	PARTS PER CAP	RAW MATERIAL COST PER CAP	VALUE OF SALVAGE MATERIAL PER CAP	NET COST OF MAT'L PER CAP	MACHINING COST PER CAP	TOTAL COST PER CAP	FINISHED PART
5-2062642 ALUM AL. ROLLED SECTION	1	336.75 IN. LENGTH 467.18 LBS. @ $.30 LB = $143.10	322.61 LBS. @ $.11/LB = $35.50	164.57 LBS. $107.60	$34.40	$142.00	5153604-2 CAP - INB'D UPPER
5-1152397 ALUM AL. EXTRUSION	1	70.00 IN. LENGTH 309 LBS. @ $.496/LB = $4.50	5.42 LBS. @ $.11/LB = $0.60	3.67 LBS. $3.90	$10.05	$13.95	5157691 CAP - OUTB'D UPPER
5-1152394 ALUM AL. EXTRUSION	1	13.875 IN. LENGTH 0.85 LB @ $.50/LB = $0.43	0.13 LB. @ $.11/LB = $0.01	0.72 LB. $0.42	$0.80	$1.22	5153014-200 FISHPLATE-INB'D & OUTB'D WING ATT.
5-1152393 ALUM AL. EXTRUSION	1	13.875 IN. LENGTH 0.40 LB @ $.50/LB = $0.45	0.15 LB @ $.11/LB = $0.02	0.74 LB $0.43	$0.80	$1.23	5153014-204 FISHPLATE-INB'D & OUTB'D WING ATT.
3"X 5/16" C.M. STEEL TUBE	1	2.25 LBS. 3.000 IN. @ $2.64/FT = $0.66	1.22 LB. @ $.006/LBS = $0.01	1.03 LB $0.65	$2.35	$3.00	1193214 BUSHING
AN 430-AD-6 RIVET	13	.0118 LB @ $.65/LB = $0.01	0.00 LB = $0.00	.0118 LB $0.01	$0.00	$0.01	AN 430-AD-6 RIVET
ASSEMBLY COST						$1.80	
TOTALS →	18	500.28 POUNDS $149.15	329.54 POUNDS $36.14	170.74 LBS. $113.01	$48.40	$163.21	



TOTAL COST OF INTEGRAL-EYE SPAR CAP ASSEMBLY = $163.21
TOTAL WEIGHT OF INTEGRAL-EYE SPAR CAP ASSEMBLY = 170.74 LBS.
COST PER POUND OF INTEGRAL-EYE SPAR CAP ASSEMBLY = $ 0.957/LB.

IN ADDITION TO THE MONETARY SAVING OF $104.14 PER SPAR CAP RESULTING FROM THE USE OF THE INTEGRAL SPAR CAP AS USED IN THE [redacted], THE INTEGRAL TYPE CAP HAS SEVERAL OTHER OUTSTANDING ADVANTAGES:

1. THE SPLITTING OF THE SINGLE BILLET TO GIVE TWO SPAR CAPS RESULTS IN A SAVING OF APPROXIMATELY 342 POUNDS OF ROLLED BILLET FOR THE TWO CAPS PRODUCED.
2. EACH SCARFED SPLICE WOULD INCREASE THE CAP WEIGHT BY APPROXIMATELY 10 POUNDS
3. THE USE OF THE INTEGRAL TYPE CAP RESULTS IN A SAVING OF APPROXIMATELY 13 MACHINING HOURS PER SPAR CAP.
4. EACH SPLICED FITTING WOULD INVOLVE THE USE OF A LARGE FORGING AND HENCE WOULD ENTER INTO ONE OF THE MOST CRITICAL PRODUCTION FIELDS OF THE ENTIRE DEFENSE EFFORT
5. EACH SEPARATE PART WOULD REQUIRE SEPARATE SHOP ORDERS AND INCREASED PAPER WORK AND HANDLING COST.

IT SHOULD BE NOTED THAT THE HIGHER TOTAL WEIGHT OF THE [redacted] SPAR CAP IS DUE TO ITS GREATER LENGTH (384.08" AS COMPARED TO 337.05") AND TO ITS GREATER END PIN LOAD (400,000 LBS AS COMPARED TO 250,000 LBS.)

inches on the breeze side. This bow is the result of the fibers in the center of the original billet being in tension and being free to act when the billet has been split into two spar caps. The fibers on the external surfaces of the original billet are in compression. The finish-milled spar caps are assigned to another Lake Erie 75-ton hydraulic press to correct the warpage.

The next operation is performed on a profile milling machine which generates tapers on the skin lug bosses. This operation also releases stresses which are manifested in side sweeps, as well as in peculiar chord bows on the outboard end of the spar caps. Again, corrections must be made on a 75-ton hydraulic press.

The spar caps are next transferred to the Williams-White 400-ton hydraulic press illustrated in Fig. 13 for bending the integral-eye lug to the proper angle for establishing the required back sweep and dihedral. For this operation, the spar cap is gripped in a heavy fixture from which only the integral-eye lug extends. This lug is then bent down, as shown in the illustration, to an angle of 4 degrees 16 minutes 18 seconds.

During the operation, the operator closely observes the movement of a scale on the machine ram with reference to a stationary pointer to see how much the part is bent. He then checks with a dial indicator along a line scribed on the spar cap prior to the operation. The integral-eye lug is actually bent 0.005 inch more than the required amount so as to compensate for spring-back which occurs during the subsequent straddle-milling operation performed on opposite sides of the lug. The straddle-milling operation is accomplished on a Farnham machine equipped with cutter-heads that feed downward. The cheek faces of the lug are finished.

The spar caps are next taken to a machine which drills, bores, and reams a hole of 2 1/2 inches nominal diameter through the integral-eye lug. Then the spar caps are transferred to the Farnham machine illustrated in Fig. 14, which mills the end of the integral-eye lug to the required radius both above and below the central flange. Two carbide-tipped cutters are used in this operation. They are mounted on a spindle which can be fed straight along one side of the lug, then around a circle, and straight back along the opposite side of the lug by movements of the cutter housing on ways on the base and a swiveling movement of the base itself.

After several detail milling operations, the spar caps reach burring benches for a series of final smoothing operations. They are then sent to still another 75-ton straightening press for any corrections that may be needed, and finally pass to inspection benches where each spar cap is minutely checked to see that it meets all dimensional specifications. Many tolerances run as close as plus or minus 0.002 inch—an accuracy that is essential in view of the fact that the dimensions of an entire wing assembly must be held as close as plus or minus 0.010 inch.

All of the machinery and tooling required in the production of integral-eye spar caps was originated by the tool and machine engineering group of the Douglas Tooling Division and engineering consultants of outside concerns. After the basic preliminary designs of machines were approved and accepted, machine tool builders were asked to construct machines to meet the requirements. The tooling was also made by vendors situated throughout the country.

The important economies obtained by adopting the integral-eye spar cap construction in place of the previous type made up of many more parts are shown both graphically and statistically in the accompanying chart. The various parts required in the previous spar cap assembly, their weights, and material and machining costs are given at the left, and the number of pieces that make up the integral-eye type of spar cap, together with costs and weights of these parts, are given at the right.

It will be seen that the total cost of spar caps of the previous type was $267.35, as against $163.21 for the integral-eye type. The total weight for the former type was only 126.30 pounds, as against 170.74 pounds for the present type. However, the former cost per pound was $2.12, whereas the integral-eye spar caps cost only $0.957 per pound. The heavier weight of the integral-eye spar cap is due to its greater length (384.08 inches, as against 337.05 inches) and to its greater pin load (400,000 pounds, as compared to 250,000 pounds).

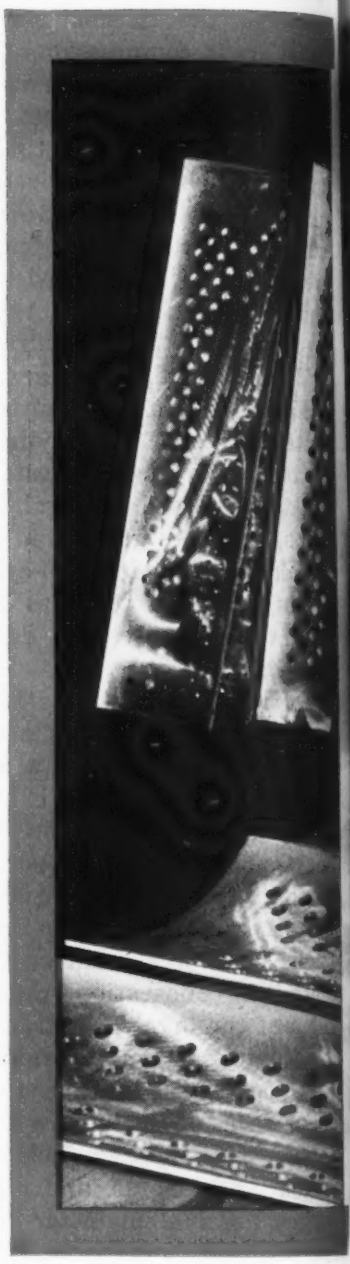
Hot-Forming Magnesium P

MAGNESIUM has wide possibilities in future aircraft construction because of the fact that it is one-third lighter than aluminum. Pound for pound, the two metals have approximately the same strength, but because there is one-third greater mass per pound of magnesium, greater rigidity can be obtained in a magnesium structure having the same strength and weight as a structure fabricated from aluminum. The application of magnesium in airplane frame construction has been retarded in the past largely because of the difficulty in forming this metal to the many contours required in plane-building. Information to overcome this difficulty should be of considerable value, therefore, to airplane designers and production men.

Northrop Aircraft, Inc., is successfully forming 1/4-inch thick J1H magnesium plates, 43 and 87 inches long, into the curved shapes shown in the heading illustration and in Fig. 3. The 43-inch length is 12 inches wide at one end and 14 inches wide at the other. The 87-inch long plates are 10 inches wide at one end and 12 inches at the other. The radii to which these plates are formed are the same dimensions as the plate widths. For example, the under-side radius of the long plate at the narrow end is 10 inches, and at the wide end 12 inches. The plates are accurately formed to templets such as are seen being applied by the development engineer in the heading illustration. The forming operation is performed after the plates have been cut to size and a large number of holes, 3/4 inch in diameter, have been drilled through them, as seen in the illustrations.

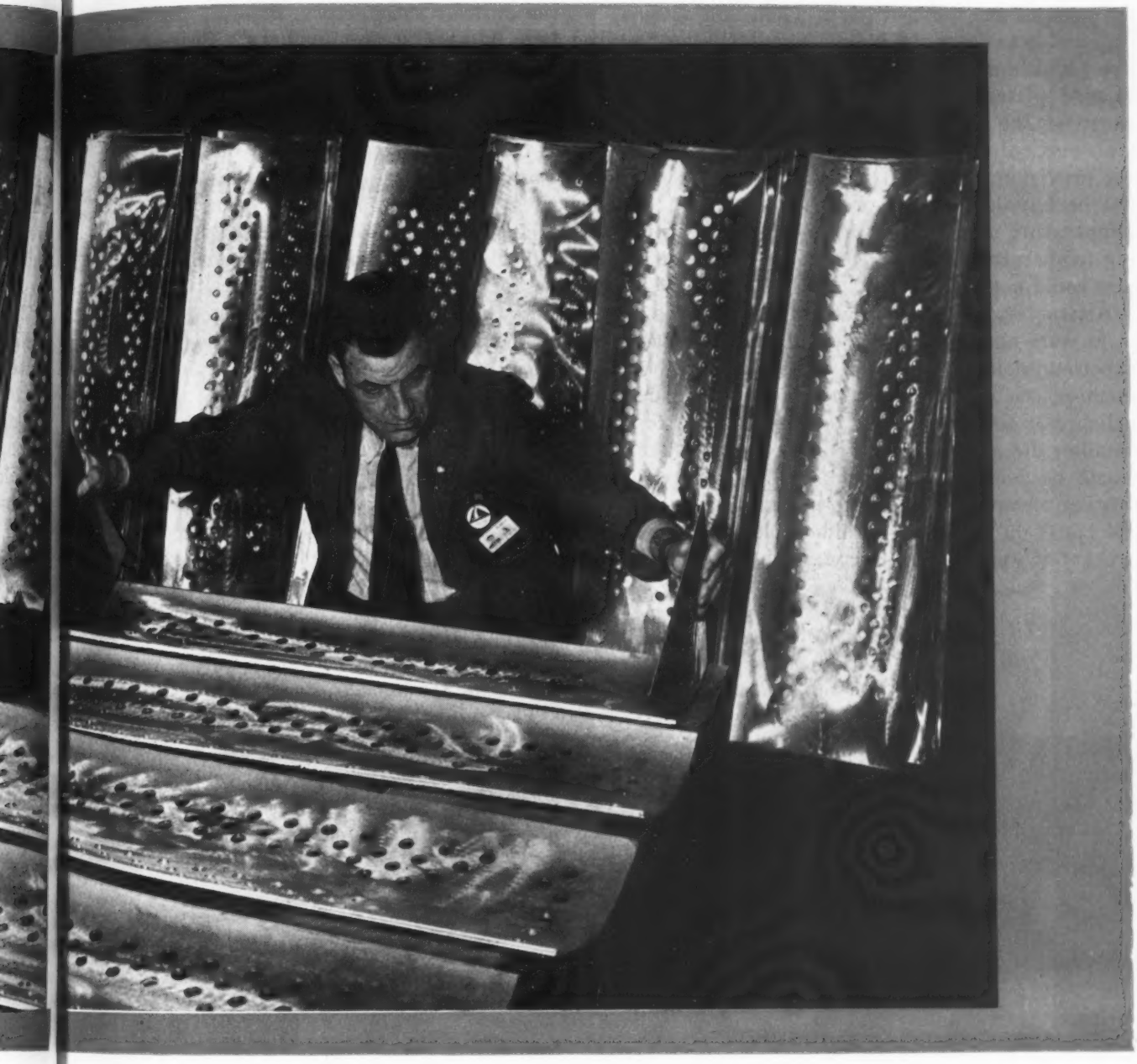
When the necessity of forming these magnesium plates originally developed, it was decided to do the work on a press brake equipped with standard V-dies, as considerable experimentation had been conducted on machines of that type. This method required approximately 500 blows. An annealing operation was necessary to relieve the strains imposed in the material by the press brake.

This method was costly because of the time involved—three man-hours per part—and also be-



By PAUL HAWLEY and ROBERT L. GUNTER
Northrop Aircraft, Inc.
Hawthorne, Calif.

Plates at Northrop . . .



Magnesium Plates ¼ Inch Thick are Successfully Formed by a Unique Process which has Decided Advantages over More Conventional Methods Originally Tried out

cause of the high rate of work rejection, which averaged 40 per cent. Excessive scrap was another disadvantage, it being necessary to perform the work on a plate approximately twice the area of the finished part. Then, too, it was impossible to form the plates smoothly after the holes had been drilled. Drilling the holes in the formed plates was an expensive operation because of the desirability of drilling each hole truly vertical to the plate. This would necessitate the provision of elaborate jigs. The plates could not be handled hot on press brakes, since the temperature of the plates dropped below a working temperature in about 45 seconds, and heated dies could not be employed.

Attempts to form the plates under drop-hammers were also unsatisfactory. Difficulties were experienced in forming the plate cold, and hot-forming seemed to be out of the question, due principally to the difficulty in keeping the drop-hammer die sufficiently hot. An open gas flame would be decidedly inconvenient, and electrical heating elements in the drop-hammer die would not last long under the hammer blows. Hydropress forming with rubber would be unsatisfactory, because the working temperature of the magnesium plates is higher than the vulcanizing temperature of rubber.

The process finally developed, which has proved entirely satisfactory, involves the use of an Erco 150-ton stretching press, illustrated in Figs. 1, 2, and 4. The ram of this machine is provided, as more clearly shown in Fig. 4, with a developed form-block of Zamac to suit the finished contours of the plates. This form-block rests on a hard maple plank, 4 inches thick, sheet asbestos being interposed between the plank and the form-block to prevent the heat in the form-block from radiating into the machine ram.

The form-block is held at the same temperature as the heated magnesium plates, the block being provided with thermostatically controlled electrical heating elements that are contained in Shelby seamless steel tubes. These tubes were cast into the form and run the full length, as indicated in the construction drawing, Fig. 5. It will be seen that the form-block on the machine in Fig. 4 is provided with seven such tubes, while the form-block on the stretching press in Fig. 2, for producing the longer plates, requires

Fig. 1. Magnesium Plates 1/4 Inch Thick are Formed Hot to Required Contours in a Stretching Press which Pushes the Plates up against a Steel Strap with Sufficient Force to Cause Them to Take the Shape of the Developed Form-block

only four such full-length tubes. The drawing in Fig. 5 also shows a form-block with seven tubes for the heating elements and the location of an eighth tube for the thermo-couple.

Extending over the top of the form-block and gripped by the long jaws on opposite sides of the ram, is a wide strap of mild steel about 3/16 inch thick. In an operation, the flat magnesium plate is slipped between this strap and the form-block, and is located on the latter by a small hole in the plate which fits over a dowel-pin mounted near one end of the form-block. Hydraulic pressure is then applied in the two cylinders of the machine to raise both ends of the stretching press ram together until the magnesium plate has been pushed against the steel strap with sufficient pressure so that the strap will force the magnesium plate down on the form-block and shape the plate to the form-block contour. The magnesium plate is formed, not stretched, by this process.

Pressure is maintained on the magnesium plates for seven to ten seconds, the length of time depending upon the exact temperature at which the plates are being formed. The hotter the plates, the less the forming time. The time of the operation is closely controlled from the instrument stand seen at the right in Fig. 1.

The magnesium plates are preheated in an electrically heated hot-air circulating oven that can be operated at temperatures up to 800 degrees F., although the plates are ordinarily heated only to between 425 and 475 degrees F. The plates remain in the oven from ten to fifteen minutes, which is long enough to insure that they are uniformly heated. It is important not to hold the plates too long at the working temperature, as the physical properties might be adversely affected. About eight plates are put into the oven at a time. The practice is to load a new plate each time that a heated plate is taken from the oven.

The plates are transferred from the oven to the stretching press by an operator wearing long asbestos gloves, as seen in Fig. 2. The steel strap becomes hot from the operations, but not excessively so, it being possible at all times to lay one's hands on the strap in the areas adjacent to the gripping jaws.

Success in this magnesium hot-forming oper-

Fig. 2. Close-up View of Magnesium-plate Forming Operation Seen in Fig. 1, Showing Arrangement of Zinc Form-block, Maple and Asbestos Insulators, and Sheet-metal Strap that Effects the Forming of the Magnesium Plate

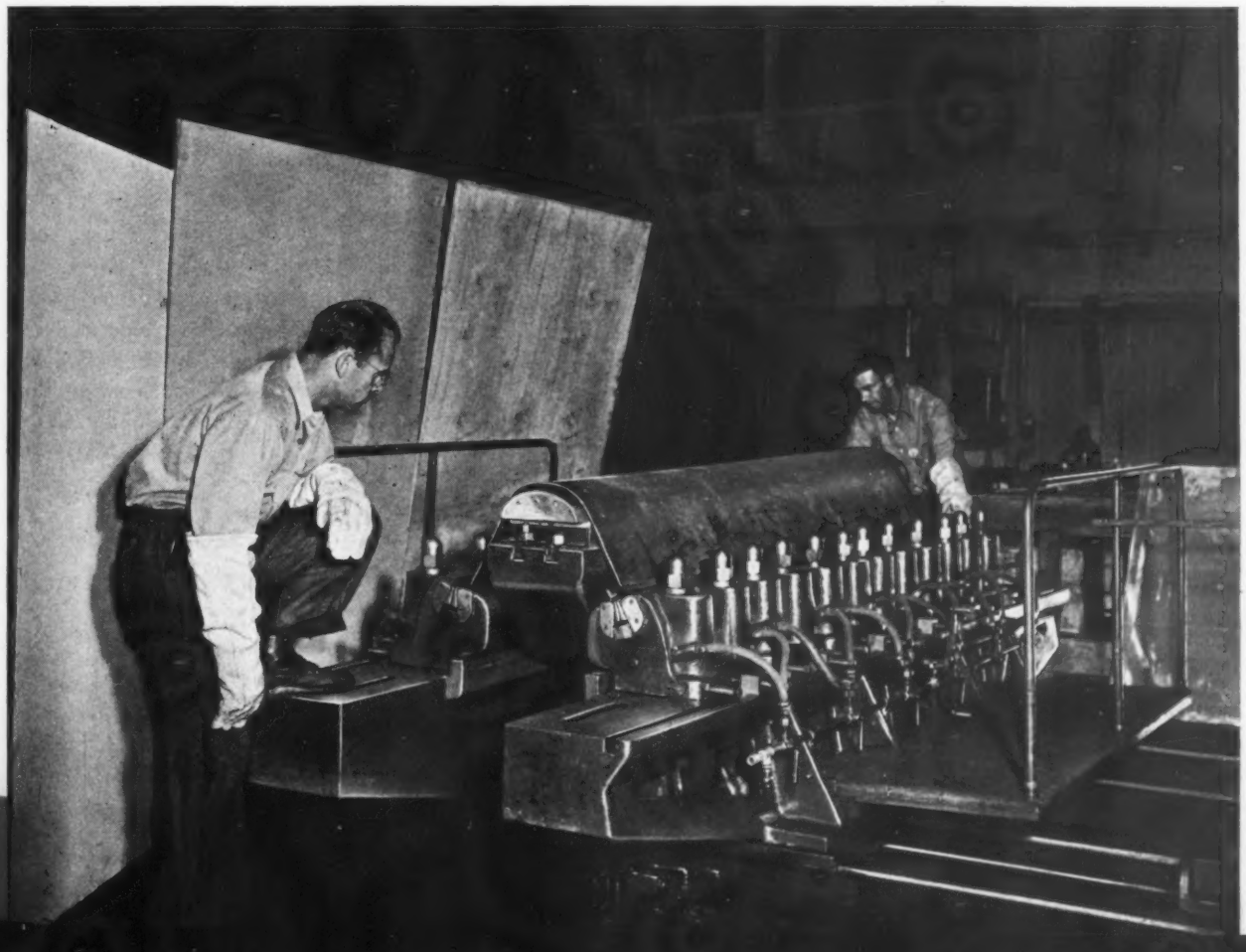


Fig. 3. The Hot-formed Magnesium Plates are Laid Individually on a Wooden Platform to Cool, rather than being Nested on Each Other, which would Cause Dimensional Changes in the Plates

ation depends primarily on three factors—first, the temperature of the magnesium plates and of the form-block; second, the forming time; and third, the humidity in the area around the stretching press. Moist air, and particularly moving air, will absorb latent heat and, therefore, the higher the humidity around the machine, the hotter the magnesium plates and the form-block must be in order to insure successful forming. Drafts particularly must be eliminated, and for this reason, the machine is well protected by surrounding movable partitions and building walls.

As there is a certain amount of creep-back in the formed plates when they cool, the practice is to over-form the plates about 0.050 inch under the crown. As the plates cool, this over-forming is reduced to 0.030 inch, which allows for additional change in the plate during later operations. In the preliminary experimentation of this process, an "undeveloped" form-block was used and the contours of this block were corrected after trial operations had indicated the amount of creep-back to be compensated for. It will be noted by referring to Fig. 3 that the formed plates are laid individually on wooden platforms to cool, and are not nested upon each other. Nesting would cause the dimensions of the plates to change beyond the prescribed limits.

Another important point to remember in forming magnesium is that too much cold-

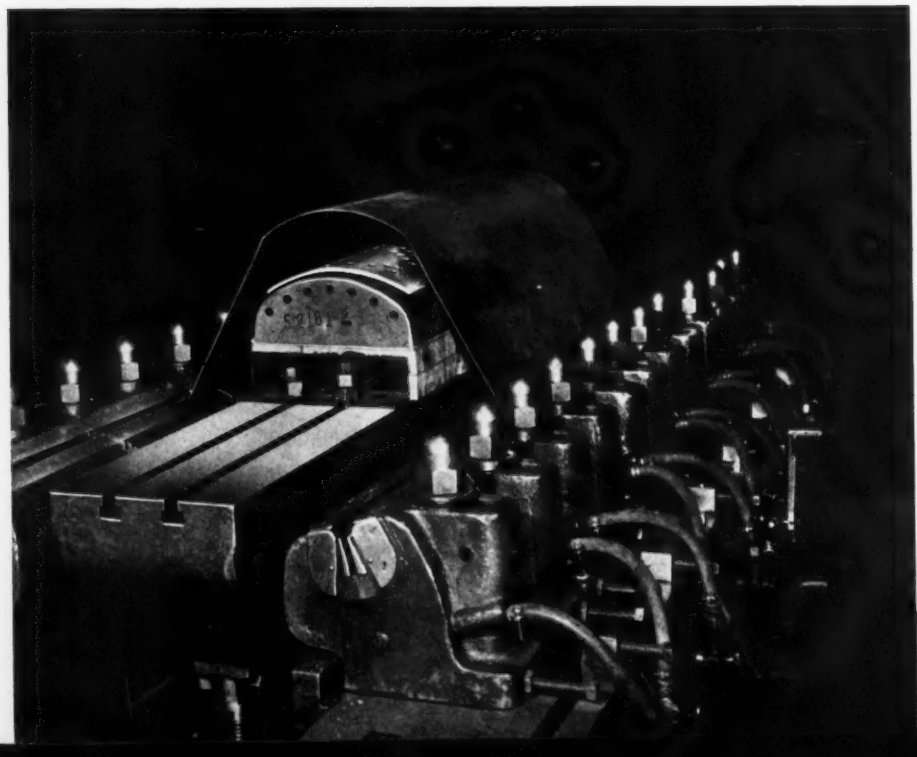


Fig. 4. Another View of the Stretching Press Set up with the Form-block Used in Producing the 43-inch Long Magnesium Parts

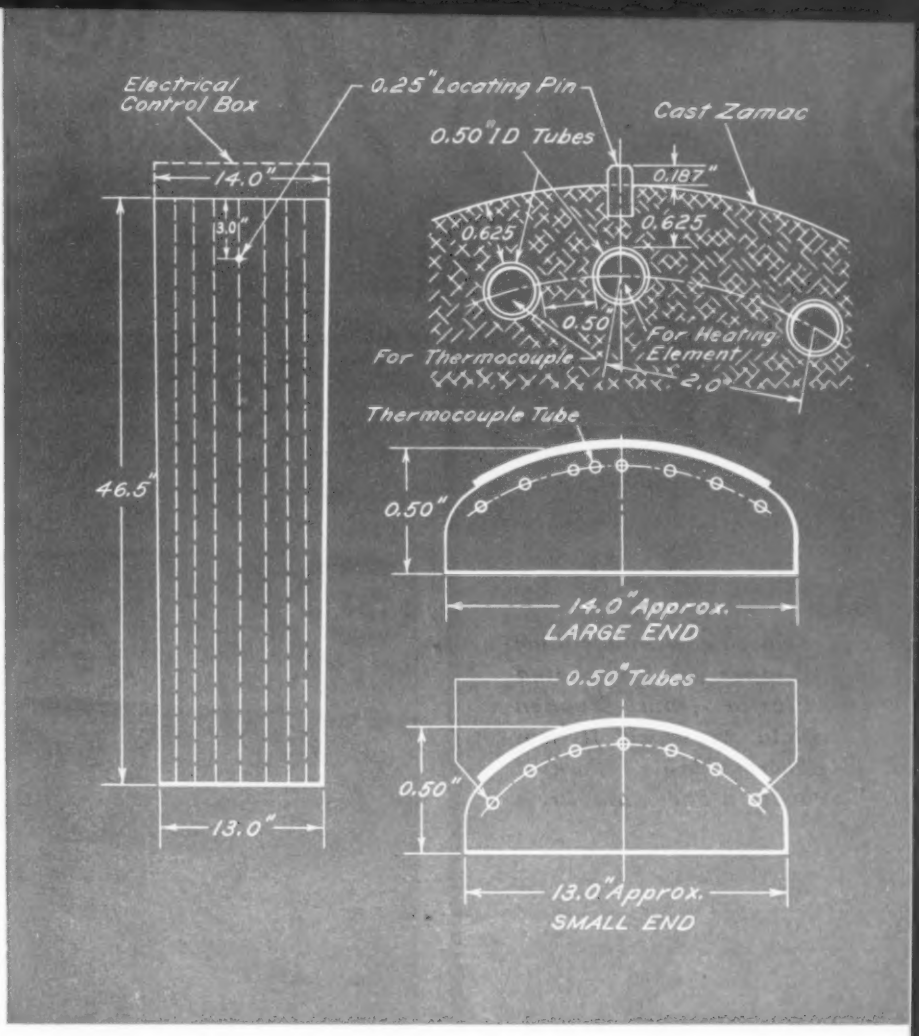


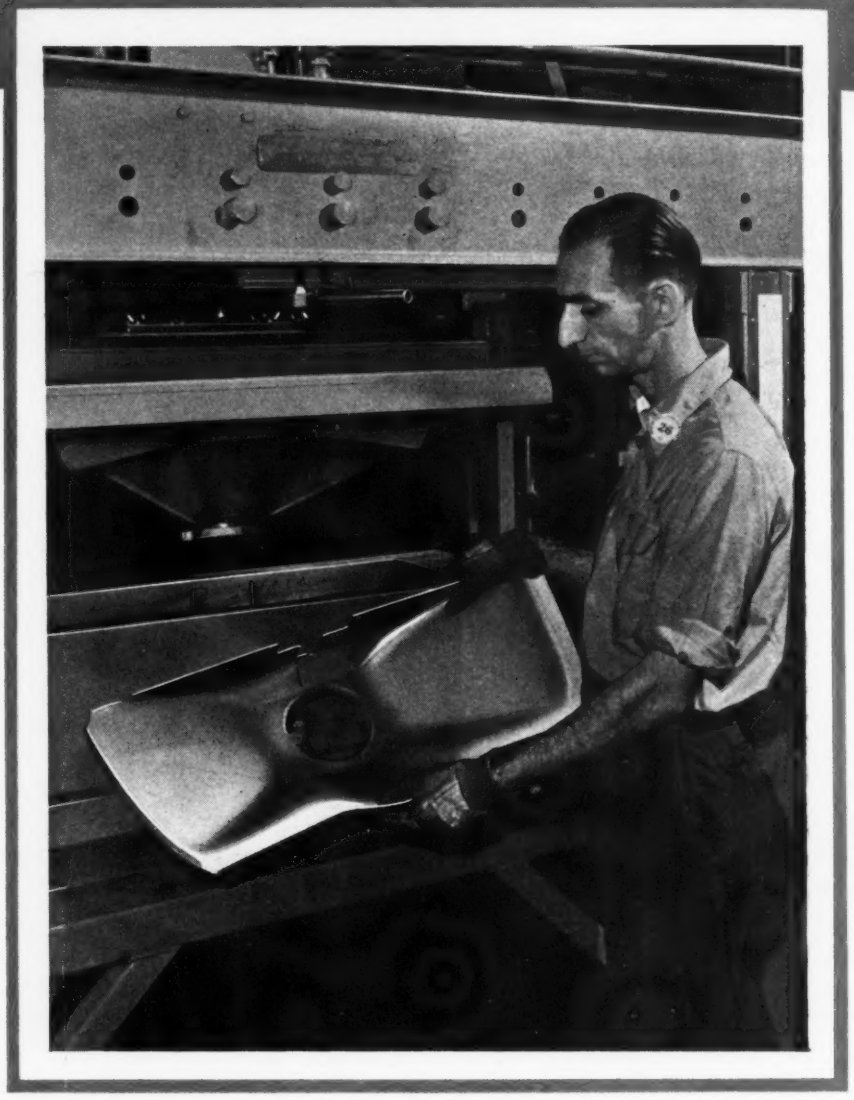
Fig. 5. Detail Drawing of One of the Formblocks, Showing the Arrangement of the Tubes Cast in the Block to Receive the Heating Elements and a Thermocouple

forming will result in excessive twinning of the magnesium. "Twinning" means a rearrangement of the grain structure and the lowering of physical properties. The grain structure of magnesium is somewhat analogous to that of a common brick wall. If magnesium is formed cold, the grain slippage will be found to occur in one plane only, whereas with heated magnesium, the slippage is in two planes. For successful forming, it is important that the plate be sufficiently hot to facilitate this slippage, but at the same time, it must be remembered that excessive heat will affect the physical properties.

The magnesium plates used in these operations have a guaranteed ultimate tensile strength of 40,000 pounds per square inch and a yield strength of 32,000 pounds per square inch. The elongation is 3 per cent.

By the hot-forming method here described, the curved plates are produced at the rate of sixty an hour with three men loading and operating the stretching press and tending the oven. Work rejections have been cut to less than one-half of one per cent, and the formed plates leave the department with the physical properties of the material unimpaired.

THERMO-ELASTIC



Removing an Ammunition Hopper of Laminated Plastic from Wooden Mold in which It was Thermo-elastic Formed under a Pneumatic Press

North American Aviation, Inc., has Made Wide Advances in the Thermo-Elastic Forming of Thermosetting Phenolic Laminates for Semi-Structural and Non-Structural Airplane Parts

By W. I. BEACH, Chief Plastics Engineer
North American Aviation, Inc.
Inglewood, Calif.

FORMING AIRPLANE PARTS FROM PHENOLIC PLASTICS

THE use of laminated plastics in airplane manufacture can go far toward alleviating some of the problems that constantly face aircraft designers. One of the most trying problems, of course, is weight control, because upon weight depends airplane performance and efficiency. Every additional pound above normal-design gross weight materially affects plane performance, and especially the performance of a plane that has been designed with maneuverability as a primary requisite. As strength is of paramount importance in airplane frames, laminated plastics cannot be used for structural members, but they can be employed as the fabricating material for a considerable number of semi-structural and non-structural parts. Judicious use of plastic parts has enabled North American Aviation, Inc., to effect a weight saving of 105 pounds on Mitchell bombers, and of 55 pounds on Mustang pursuit ships.

In the actual manufacture of aircraft, there is no more important problem than production man-hours. There are a number of instances where the substitution of laminated plastics for aluminum alloys has substantially reduced production hours in the building of North American planes.

An excellent example is an ejected ammunition case and link hopper which was originally produced from four components of sheet alumi-

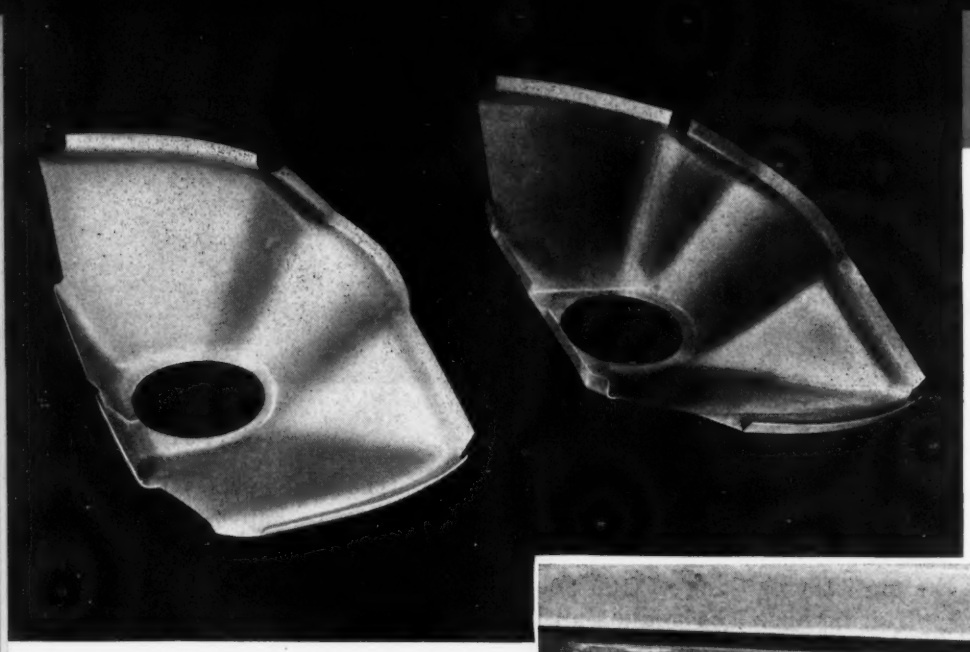


Fig. 1. At the Right is Seen an Ejected Ammunition Case and Link Hopper as Originally Constructed by Welding Four Aluminum Pieces together, and at the Left, the Single Formed Plastic Part that has Replaced the Metal Hopper

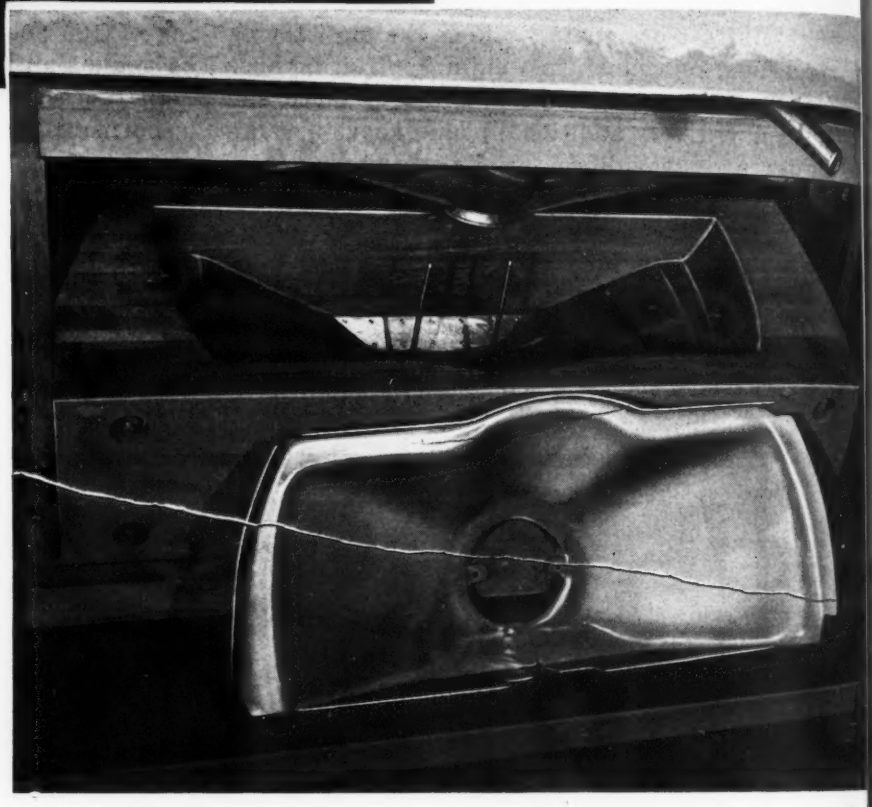


Fig. 2. Wooden Punch and Die Mounted on a Pneumatic Press for Forming Comparatively Large Plastic Parts by the Thermo-elastic Process

num welded together, as seen at the right in Fig. 1, and is now made of a single piece of formed plastic, as shown at the left. Forty inches of seam welding were formerly required to assemble the four aluminum parts after they had been produced by cutting, routing, and forming operations. The total time consumed in making the aluminum hopper was 1 1/4 man-hours, whereas the equivalent plastic hopper is made in only 19 minutes. A remarkable fact, too, is that the plastic laminate hopper stands up better in service than the aluminum one, as the plastic material is more resistant than aluminum to the scarring action of cartridges.

Before describing the technique employed in the Inglewood, Calif., factory of North American Aviation, Inc., in the manufacture of phenolic plastic parts by the thermo-elastic process there developed, it should be pointed out that formability has not been regarded, in the past, as a paramount attribute of thermosetting plastic. The general attitude of plastic engineers has been to overemphasize moldability instead. Forming of heat-hardening materials was inconceivable to those who have leaned heavily to the premise that thermosetting resins were insoluble and irreversible. These engineers did not suspect, for instance, that thermosetting laminates could be elongated 40 per cent or that a specimen stretched 17 per cent or more would possess an ultimate tensile strength 80 per cent greater than its normal value unstretched.

Other latent properties that make for formability are present in thermosetting plastics. Some of these properties are evident only after the material has been processed for forming.

The North American thermo-elastic forming process is based on the use of the finally cured or "C" stage phenolic laminated fabric-base sheets. This process is not to be confused with the conventional "B" stage operation performed on plastic sheets in the unpolymerized condition or with the low-pressure resin process. This thermo-elastic method deals with thermosetting phenolic laminated sheets that meet Federal specification HH-P-256 which defines certain minimum properties.

Because approximately 85 per cent of the production activities in an airplane-building plant consist of working and fabricating metal sheets, a brief analogy between aluminum alloys and thermosetting laminates will be of interest to aircraft engineers. Any comparison must, of course, be relative, due to the extreme differences in their physical composition. In the case of S-O aluminum, bending or drawing is accomplished by a corresponding sliding of the crystals along slip planes. It may be said that slippage occurs along any of three axes, depending upon the direction of force that is causing distortion of the crystalline structure. Although thermosetting plastics cannot be said to possess slip planes, they are not restricted to directional forming. Whereas aluminum is deformed by slippage of crystals along planes of weakness, laminates are deformed by an incremental sliding and stretching of adjacent fabric layers.

With aluminum, drawing or bending is generally accompanied by a reduction in thickness at the critical section. Thermosetting materials give no evidence of reduction in thickness, and often as not increase slightly in thickness at the critical bent or drawn section. Since the adjacent layers of fabric obviously stretch, this increase in sectional thickness must be accounted for by a redistribution of binder and filler and warp threads.

Owing to the fact that S-O aluminum possesses greater elongation than 24 S-T aluminum, deep forming or drawing operations are generally performed on the softer material. Compared to this material, thermosetting laminates have an elongation of less than 3 per cent. However, when treated properly, it is possible to form objects from thermosetting laminates that cannot be duplicated in 24 S-T aluminum, and that are difficult to make from S-O aluminum. Contrary to one school of thought, thermosetting laminate, like aluminum, tends to increase slightly in strength as a result of treatment.

Fig. 3. Large Rotary Table Loaded with Wooden Molds of Different Types Used in Forming Plastic Blanks into Pieces that have been Substituted for Metal Parts

Fig. 4. Hand-operated Die in which the Plastic Blank is Formed by Closing Two Hinged Jaws and Moving a Slide Forward

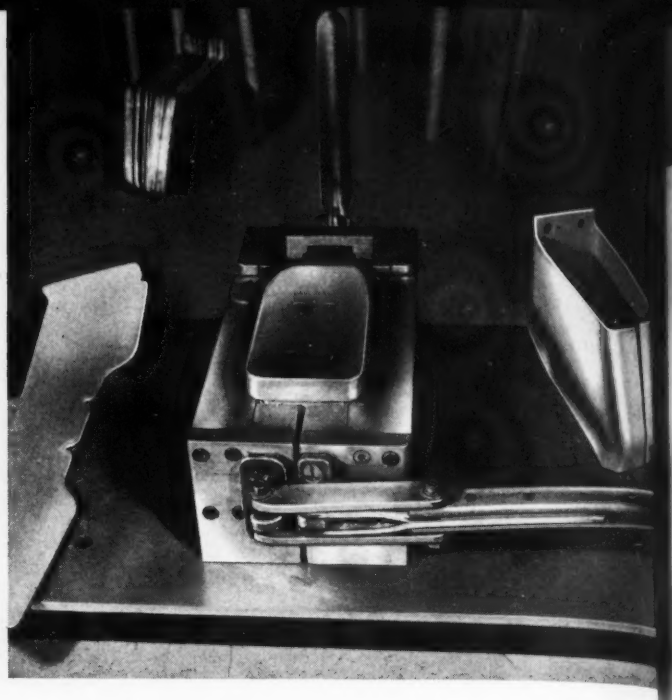


Fig. 5. Another View of the Die Shown in Fig. 4, with the Jaws and Slide Closed. A Finished Piece is Seen at the Right

When metals are strained within the elastic limit, they return to their original shape upon the release of the deforming force. Consequently, bending and drawing operations must deform the material beyond its elastic limit. Repeated cold-working increases the resistance of metal to additional forming operations. On the other hand, while the bending or drawing of aluminum is limited by the effects due to cold-working, the phenolic laminates may be formed and reformed many times.

The thermo-elastic process of forming thermo-setting laminated plastics appears simple enough, but its success depends greatly upon complete knowledge of the fundamentals involved. The molds are built up principally of hard wood, fashioned by the art of the patternmaker, or of Kirksite. Masonite bases are often provided.

Laminate sheets up to 1/4 inch in thickness are regularly formed. The practice is to cut out the blanks in multiple on routing machines of the type found throughout the aircraft industry. In most cases, about ten blanks are stacked on top of each other for the routing operation. After having been cut out, these blanks are individually heated, ready for forming.

The blank being handled in the heading illustration on page 182 is for an ammunition hopper. It has an over-all length of approximately 3 feet, and is about 18 inches in maximum width. Prior to heating, two small holes are drilled through the sheet for locating the blank over pins in the mold die. The details of the lower half of this mold are clearly seen in Fig. 2, while the construction of the upper half or punch is apparent from the heading illustration. The locating pins are near the center of the bottom half of the mold. The appearance of the formed piece is shown by the example lying at the front of the mold in Fig. 2. It is formed to a depth of approximately 10 inches.

The ammunition hopper, as well as all other parts of comparatively large dimensions, is formed under a pneumatic press equipped with an overhead cylinder for the ram. A pressure up to 5 tons can be built up in this cylinder with a line pressure of 100 pounds per square inch. In forming the ammunition hopper, a pressure of about 10 pounds per square inch is applied all over the blank area. Three pneumatic presses of the type described are installed in a row.

From eighty to ninety parts of different types are now being formed from plastic sheets by this thermo-elastic process, many of the pieces being produced in hand-operated dies or molds. These are generally arranged around a circular table, as illustrated in Fig. 3. Two men customarily load the heated blanks into the molds and close them, while a third man opens the molds and removes the formed parts. The table can be revolved easily by hand.

A typical hand-operated mold used on the rotary table is illustrated in Fig. 4 in the open or loading position with a plastic blank in place, ready to be formed. In forming, two hinged jaws are closed against the sides of the central sta-

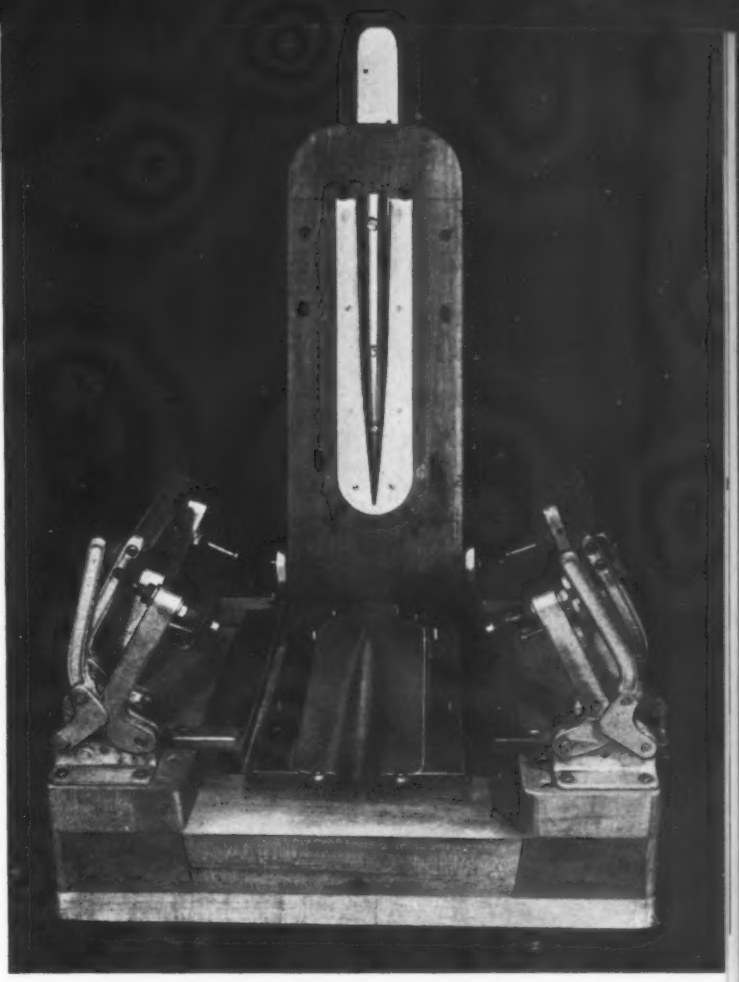


Fig. 6. Plastic Forming Mold of the Type having a Hinged Cover that Swings Upward, the Upper Half of the Mold being Attached to This Cover

tionary member and firmly locked together by means of a quick-acting handle seen attached to the right-hand jaw. A slide at the back of the mold is also advanced against the blank by pulling a handle upward. This slide is provided with two locating pins that enter holes previously pierced in the blank. Fig. 5 shows this mold closed with a plastic blank at the left and a finished part at the right. This mold is constructed entirely of Kirksite, with the exception of the handles, which are Masonite.

Another typical mold design is illustrated in Fig. 6. In this case, a hinged cover carries the upper portion of the mold, which corresponds with the punch on pneumatic press dies. The flat plastic blank is located between dowel-pins on the bottom half of the mold, rather than being slipped over such pins. After the top cover has been pulled down into place, hinged clamps on opposite sides of the mold are tightened firmly on top of the cover in the manner illustrated in Fig. 7. Effective locking means of this type are necessary on all hand-operated molds to insure that none of the forming members move even slightly during cooling of the plastic part.

Paraffin oil is customarily applied twice a day to all die and punch surfaces to insure easy sliding of the plastic sheets over the forming surfaces. While all the mold and die examples shown have been equipped with pins for locating the plastic blanks, there are many instances where small pads of Kirksite, wood, or Masonite serve the same purpose. Sometimes, pads and pins are used in combination. Masonite is also used extensively on wood molds to protect edges that are susceptible to chipping.

Thermo-elastic forming is still in its infancy, but its successful application in the North American plant should go far toward convincing aircraft engineers and production men that plastics have a definite place in aircraft design and that such applications will probably widen extensively in the post-war period. It is conceivable that the future airplane may be constructed with wings covered with aluminum, strengthened by steel spars and reinforced with high-strength plastic ribs. Perhaps the side panels of the fuselage will be covered with a plastic material. In the interior of the fuselage plastics may be applied effectively in building up floors, doors, compartment bulkheads, and fixed equipment. In any event, plastics have been proved sufficiently serviceable under tests of limited strain, and in actual service, to warrant their acceptance as aircraft material. Of prime interest to the aircraft engineer is the fact that plastics weigh only half as much as aluminum.

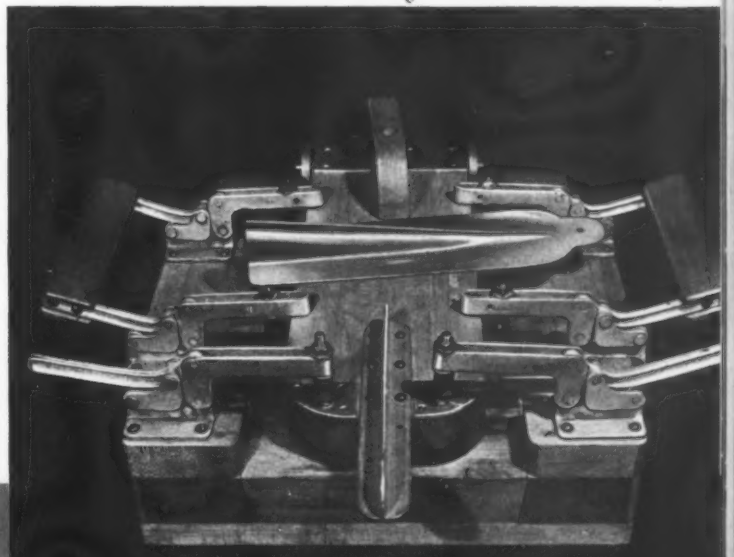
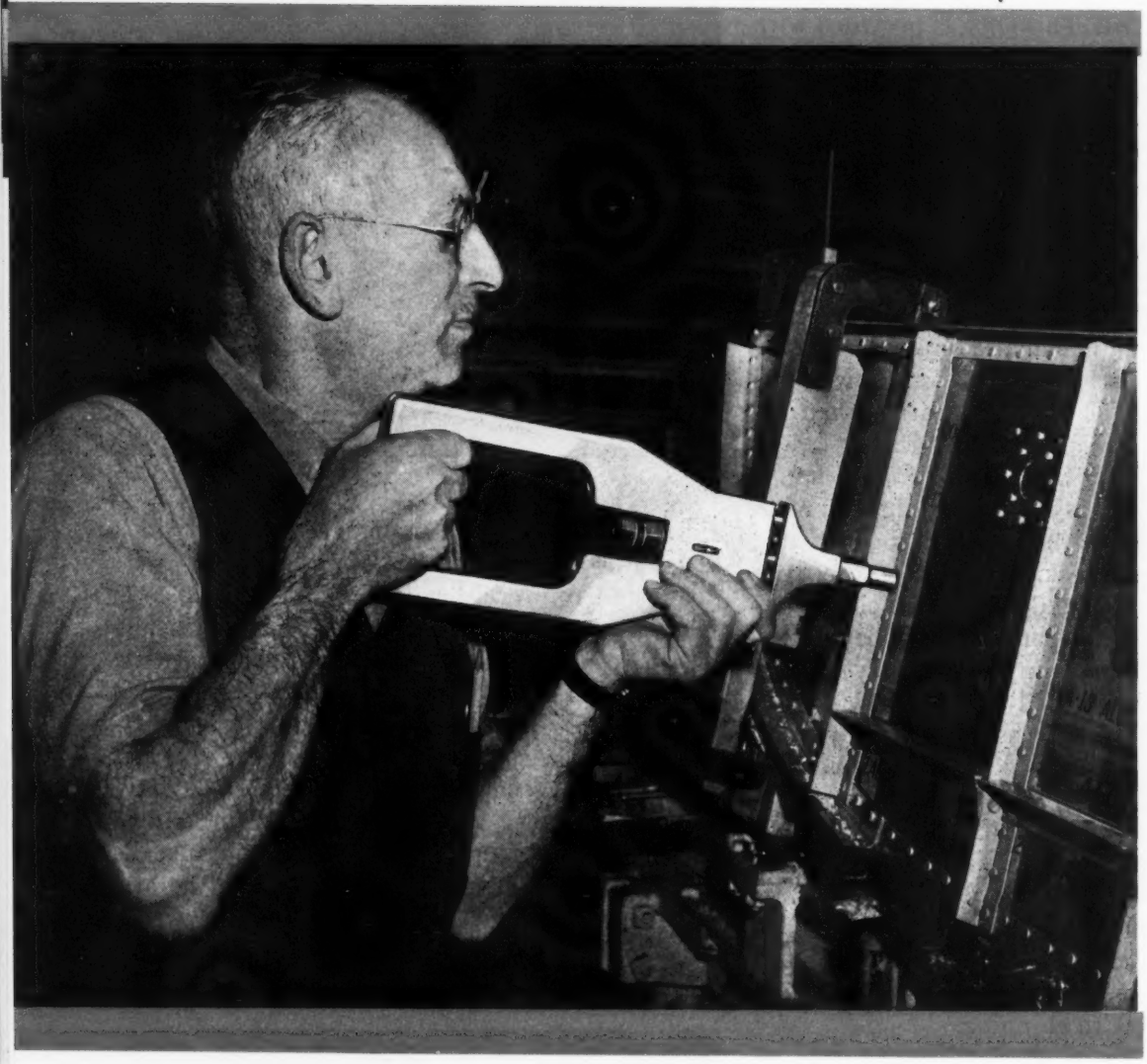


Fig. 7. Another View of Mold Seen in Fig. 6, with Hinged Cover Closed and Six Clamps Providing a Firm Holding Pressure on Top of the Cover

Consolidated Vultee Development Expedites



Savings in Materials, Reduced Manpower Requirements, Increased Output, and Improved Workmanship are Some of the Advantages Derived from Radically Different Rivet-Bucking Devices of Portable and Built-In Types

Bucking-Bar Production Riveting

By E. P. MYERS, Chief Tool Engineer
Consolidated Vultee Aircraft Corporation
San Diego, Calif.

BUCKING devices based on a principle that results in a number of important advantages have practically revolutionized riveting methods in the factory of the Consolidated Vultee Aircraft Corporation, San Diego, Calif. These bucking devices are made in various assemblies to suit both manual and automatic riveting operations. Essentially, each bucking assembly consists of a floating bar, which is positioned against the shank end of the rivet, and two or more spring-actuated reacting plungers or hammers that operate against the back of the bar in response to impulses which are imparted by conventional type air-driven riveting guns.

The reacting hammers are not connected to the bucking bar, but the riveting gun impulses are transmitted through the bar to these hammers. A rubber stop adjacent to each of the reacting hammers holds the floating bar continuously against the rivets, dampening any vibration of the bar during riveting. Vibrations set up in the reacting hammers augment and oppose the impulses of the riveting gun.

The heading illustration shows one of the portable bucking devices being used by Morris Brown, the man who conceived the idea, while Fig. 1 shows the application of automatic types of bucking devices installed on a typical assembly jig. The automatic types can be built into jigs for driving substantially all rivets in an aircraft assembly and thus completely eliminate manual bucking.

In automatic bucking devices, the floating member consists of a long steel bar that extends behind a row of rivets and is supported at each end by means of a device which serves to guide the bar and support the reacting hammer and rubber dampeners. This device is pivoted to the framework of the jig, so that the bucking bar is held flexibly. This arrangement helps to locate the bar against stringers or other reinforcements in the assembly being riveted. The bar need not be straight or horizontal. It may be curved, offset, or placed at an angle to suit the configurations of any line of rivets.

Fig. 2 shows a large assembly jig with a considerable number of these bucking-bar devices,

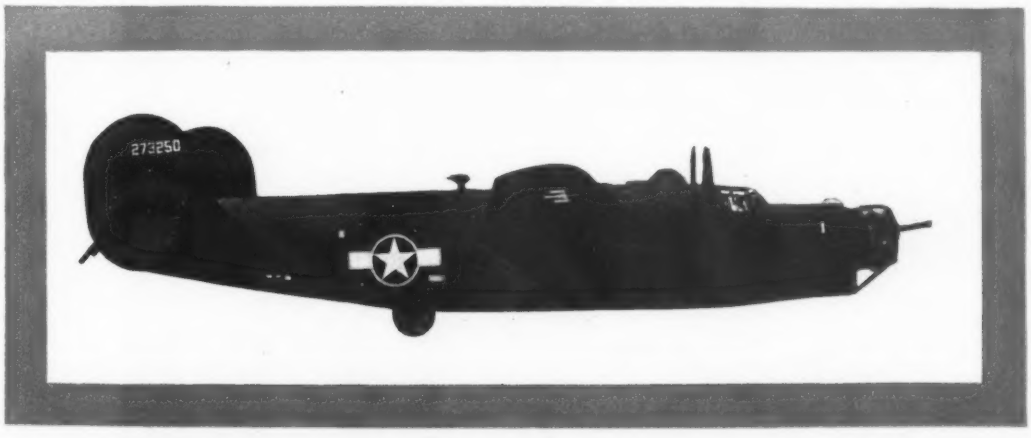


Fig. 1. Riveting a Section of Wing Skin in a Jig Equipped with Automatic Bucking Bars that are Provided with Reacting Hammers that Augment and Oppose the Impulses of the Riveting Gun

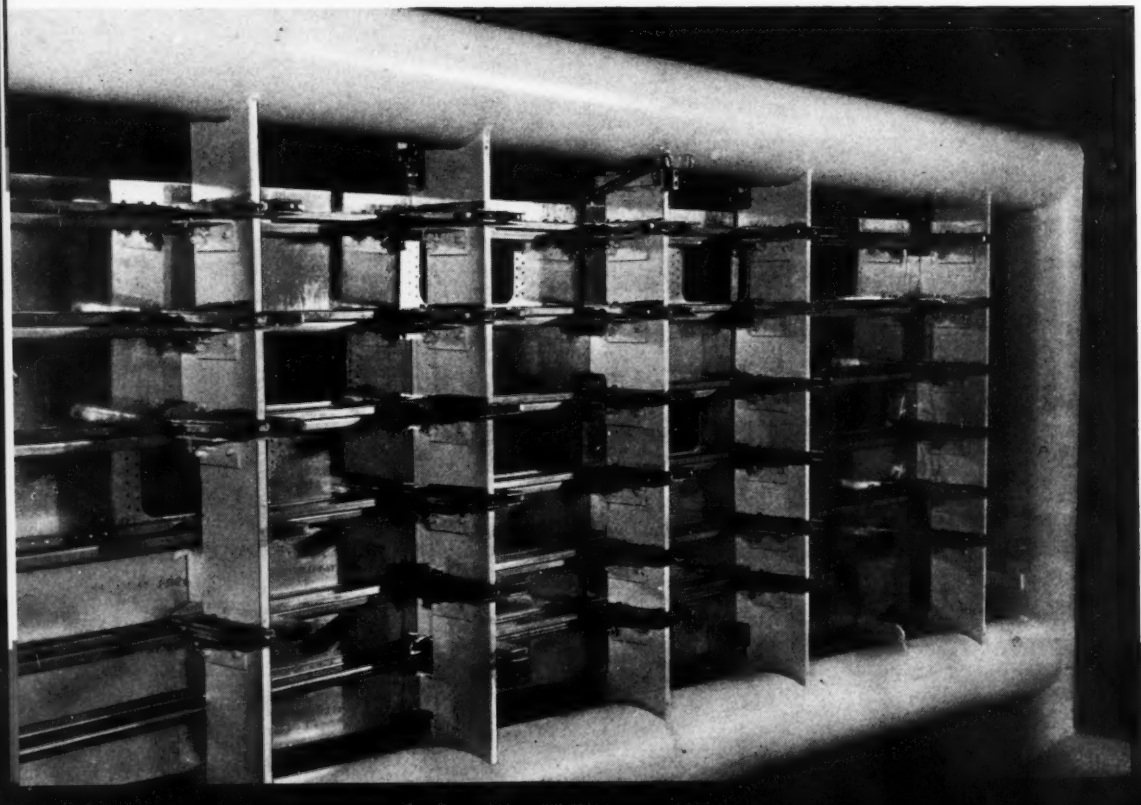
Fig. 2. Section of a Large Aircraft Jig Provided with Automatic Bucking-bar Assemblies Sufficient to Accommodate All the Riveting Operations Performed in This Jig

while Fig. 4 shows a close-up view of two typical bars, one being horizontal and the other placed at an angle. Provisions can be made on the bucking bars to accommodate rivets of different sizes or groups of rivets adjacent to a main line. There is a gage on each supporting device, which controls the size of the upset rivet head, thus promoting uniformity of riveting and preventing over-riveting.

The use of these bucking devices eliminates "oil canning" or deforming of airplane skin, which is particularly important in all operations where smoothness of contours is essential. The mass of the bucking bar is always so positioned that the sheets being riveted cannot be deformed by hammering on an unsupported rivet. Thus, the common mistakes of a bucking-bar manipulator can be wholly eliminated in jig riveting, since no second man is required. Each bucking bar protects an entire row of rivet holes and gages the size of each driven rivet head. The gun operator knows when to stop hammering by the change in the sound of the hammer blows when the rivet head has been formed.

These jig rivet-bucking assemblies are particularly valuable in countersunk riveting, which generally necessitates the services of the most highly skilled rivet teams. With the new bucking bars, an unskilled workman can drive a perfect row of countersunk rivets without "oil canning" or dimpling of skin surfaces.

The tooling cost of the new method is small, in view of the savings effected. Experimental set-ups have indicated a 48 per cent time-saving



in the riveting of a single line of rivets. Operator fatigue has also been greatly reduced.

A variety of manual or portable bucking-bar devices have been created for riveting jobs on work that is not held in a jig or fixture. Two of the portable types are shown in Fig. 3. While some of these types are larger than conventional bucking bars, they are light in weight and shaped for easy handling. The manual type generally consists of a bucking bar that is shaped to suit the particular job for which it is intended. The reacting hammers are enclosed within a light-weight handle.

For work on rows of rivets, a bucking bar of the portable type has a rectangular-shaped face, as seen at the left in Fig. 3, which enables the workman to cover several rivets simultaneously. This eliminates the likelihood that the bucker will support one rivet while the gun operator drives another. The bucking-bar device that is seen at the right in the illustration is intended for use in tight spots, where only one rivet can be supported at a time. Such an operation is shown being performed in the heading illustration on page 188.

No marked muscular effort is required in using the manual types, as the reacting hammers absorb the impact of the rivet gun blows. These manual bucking-bar assemblies are adjustable by means of a bolt that extends from the bucking-bar through the shank end of the handle. Adjustment of the bolt makes it possible for the reacting hammers to absorb all or any part of the energy expended by the rivet gun, as desired.

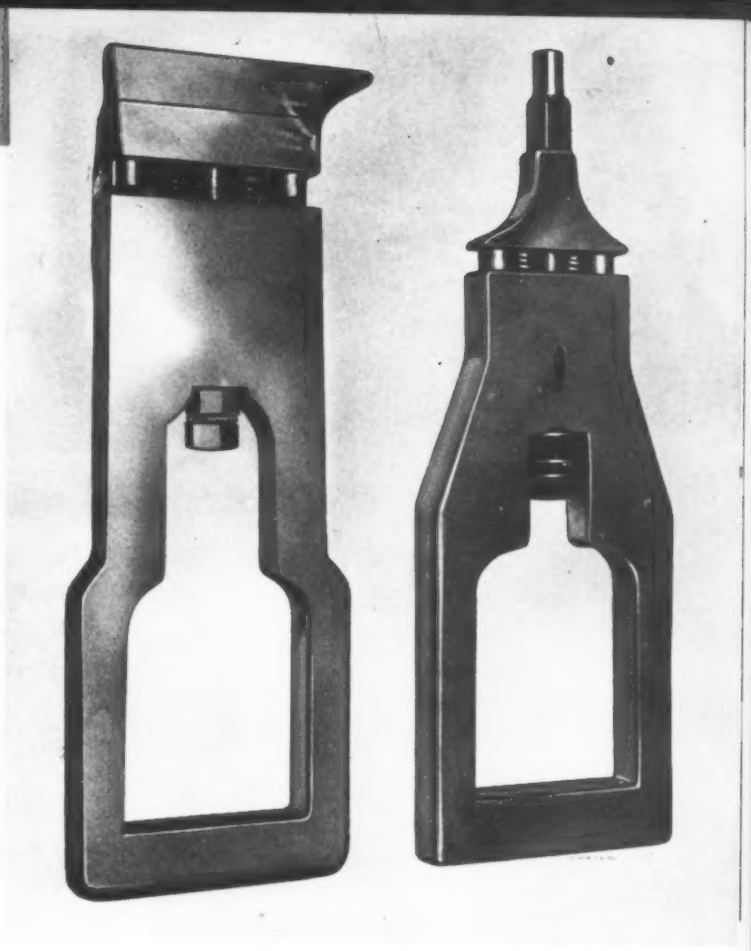
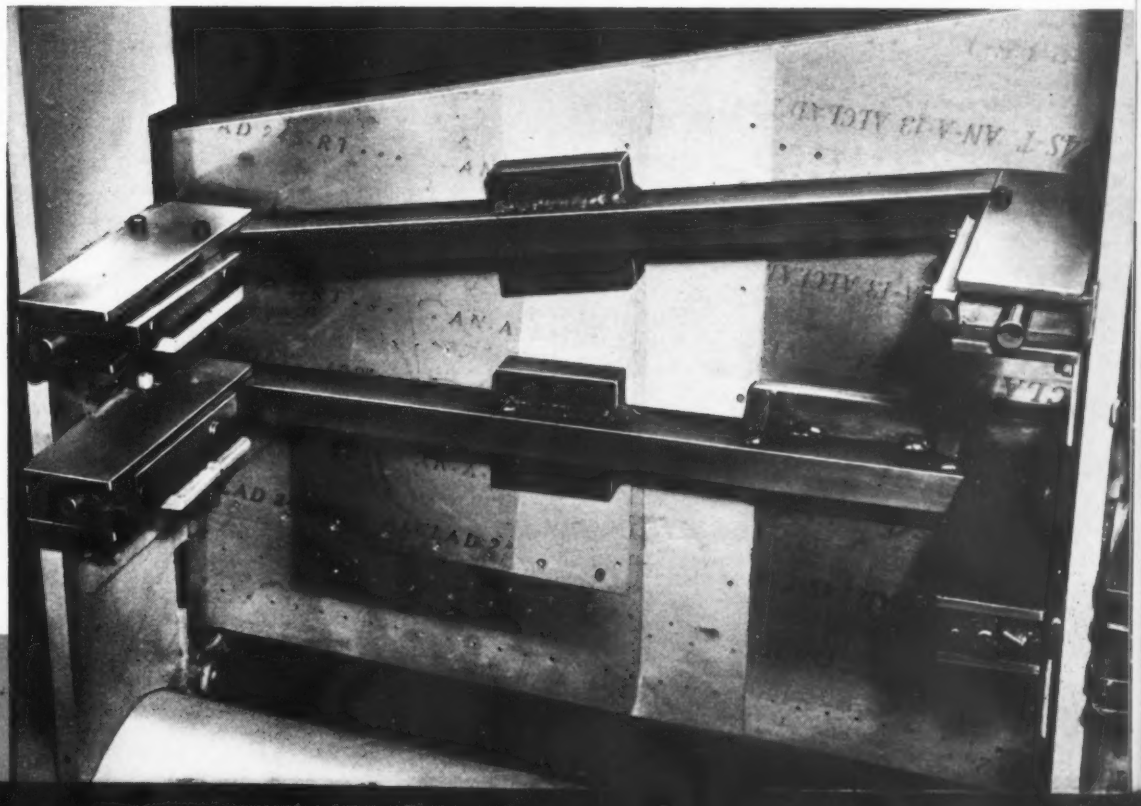


Fig. 3. Two Portable or Manual Bucking-bar Devices Equipped with Reacting Hammers that Expedite the Riveting Operation, and at the Same Time, Practically Eliminate Fatigue of the User

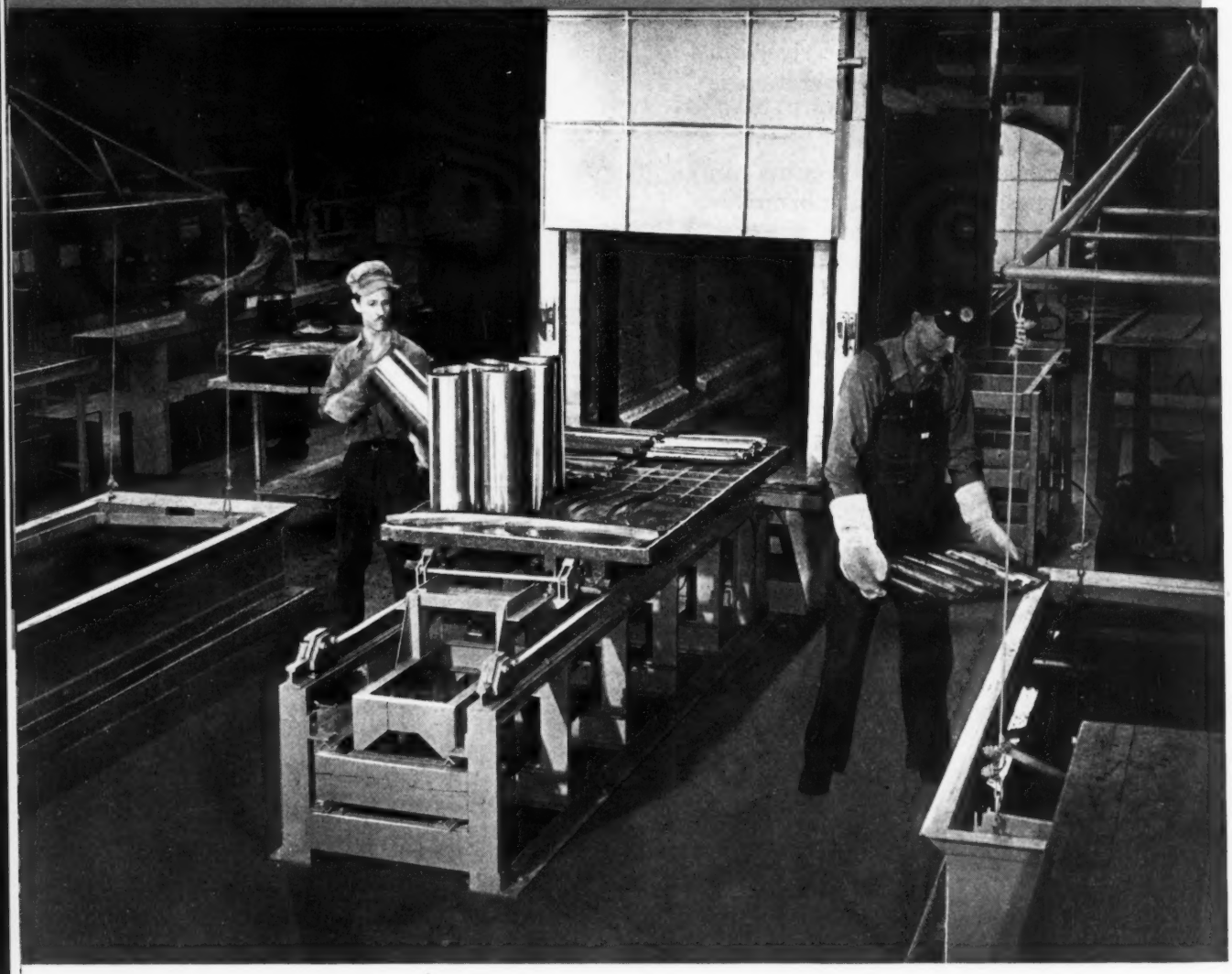
Fig. 4. Special Bucking-bar Adaptations such as the Two Here Shown Make It Possible to Apply the New Consolidated Vultee Riveting Method to a Large Variety of Jobs



Expediting Anodizing

Mechanical Aids which Save Time for Skilled Workers have Helped Curtiss-Wright to Meet Its Increased Production Schedules in the Face of Labor Shortages

By E. K. FRY, Assistant Superintendent
Columbus, Ohio, Plant, Curtiss-Wright Corporation



Curtiss-Wright Heat-Treating, and Plating . . .

At the Curtiss-Wright plant in Columbus, built especially for the production of Curtiss Helldiver dive bombers for the Navy, much has been accomplished during the past year to speed these planes to the battle-fronts. In the large and unusually well equipped heat-treating department, for example, the flow of parts through heat-treating, anodizing, electroplating, and inspection operations has been greatly aided by a full utilization of mechanical handling equipment, including stabilized cranes, monorail hoists, overhead chain conveyors, and platform roller conveyors. Although there has been a 35 per cent decrease in the number of workers in this department during the past year, production has been increased and a much better control over the flow of parts in process has been established by improved handling methods.

Referring to the plan view of the heat-treating department shown in Fig. 1, the area at the right is devoted to aluminum heat-treating, anodizing, inspection, and rivet refrigerating operations. In the area at the left, steel heat-treating and inspection operations are conducted. In the area shown just to the left of the center of Fig. 1, a complete lay-out of equipment is maintained for chromium-, zinc-, and cadmium-plating. Several small heat-treating furnaces for tools are shown in the right-hand area.

Considering the aluminum heat-treating operations first, the aluminum parts enter the heat-treating department on an overhead process conveyor at point *A* in Fig. 1. They are unloaded from this conveyor at point *B* for transfer to one of the four heat-treating furnaces near by. Fig. 2 shows a workman unloading parts at this station. One of two Lindberg horizontal air draw furnaces appears in the background. The one shown has a heating chamber about 3 feet wide by 3 feet high by 14 feet long. The other has an oven of the same width and height, but only 6 feet long. Both furnaces are of the car type and, as shown in Fig. 1, are located along the same track.

A quench tank is conveniently placed at both sides of the unloading section of the track for each of these furnaces, as shown in the heading illustration on page 192. With this arrangement, if the parts that have been heat-treated are numerous, two workmen can unload them from both sides of the car and place them immediately in a quenching bath with the least possible lapse of time.

On the other side of the process-conveyor unloading station is a large Lindberg vertical air draw furnace 13 feet long, 4 feet wide, and 7 feet deep. This is believed to be one of the deepest air draw furnaces in the country, and is used

to handle large aluminum sections. Long ribs and spars, for example, can be suspended vertically in this furnace, which is designed so that a larger number can be accommodated at one time than could ordinarily be placed in a horizontal furnace of comparable size.

The crane shown lowering the large aluminum sheets into the furnace in Fig. 3 is of a special stabilized design. When the load is raised or lowered by this crane, no side sway is imparted to it. In fact, the load-supporting frame is held so rigidly that any attempt to push it from side to side results in only very slight movement.

Referring back to the plan diagram, Fig. 1, it will be seen that, in addition to this vertical air draw furnace, there are two Ajax-Hultgren salt bath furnaces near by, one of which is 15 feet long by 3 feet wide by 54 inches deep, and the other 10 feet long by 3 feet wide by 54 inches deep. The same stabilized crane can be used to remove heat-treated parts from either the large salt bath furnace or the vertical draw furnace and to quickly dip the pieces into the cold water quench or warm water rinse tanks and then place them on the draining and unloading stand. A 50 per cent increase in production has resulted from the establishment of this method of handling the aluminum parts during the heat-treating operations.

Having passed through the necessary heat-treating operations, the aluminum parts are reloaded on the overhead conveyor at point *B* and pass out into the main factory area for line-up and inspection.

When these parts are ready for finishing, they again enter the heat-treating department at point *A* on the process conveyor, and are unloaded and placed on a belt conveyor at point *C*. They pass down this conveyor to the racking stand where the smaller aluminum pieces are

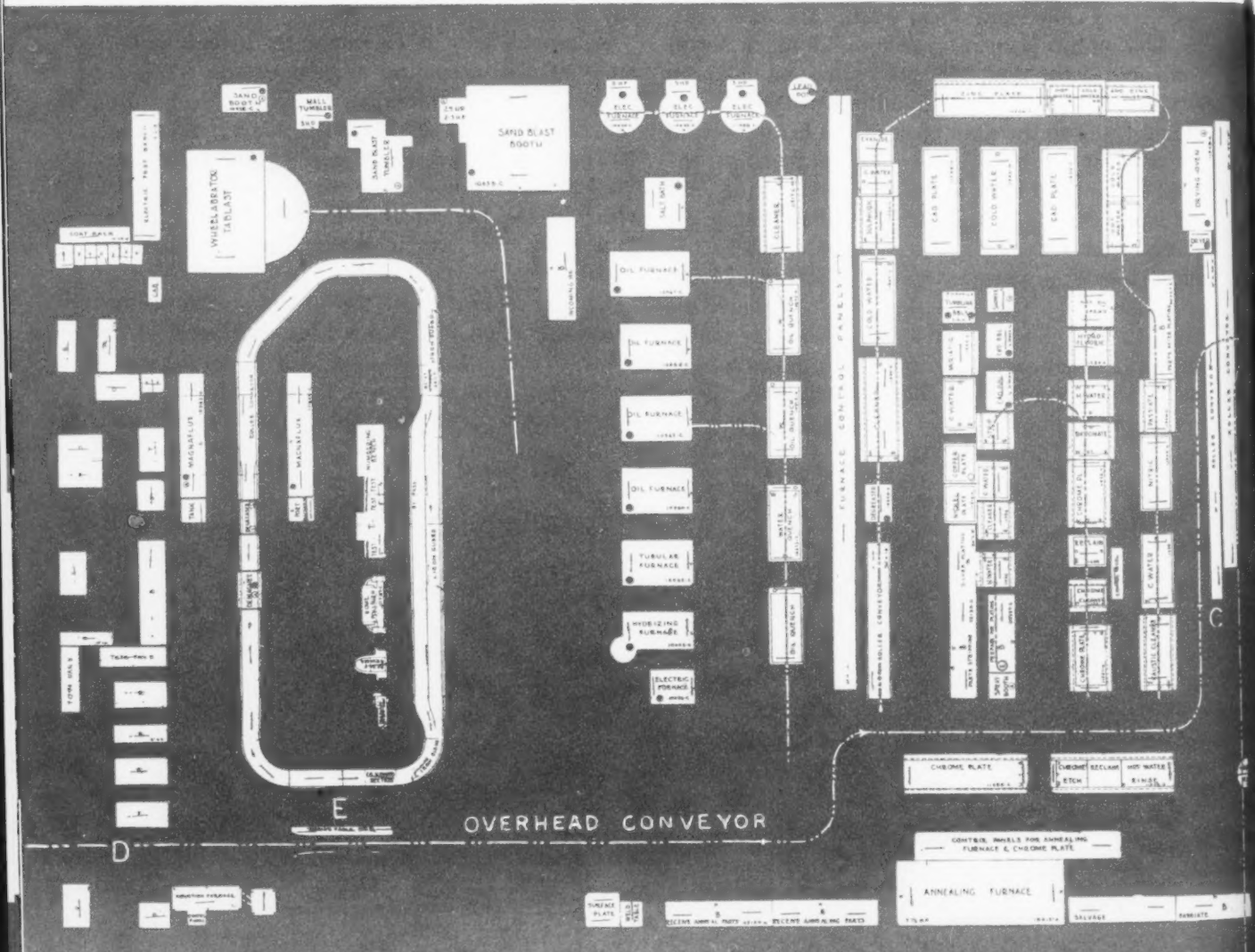


Fig. 1. Plan View of Heat-treating Department. From Left to Right are Inspection Area, Steel

placed in coil-spring holders which separate them for hanging on the immersion racks, and the larger pieces are suspended directly from the racks.

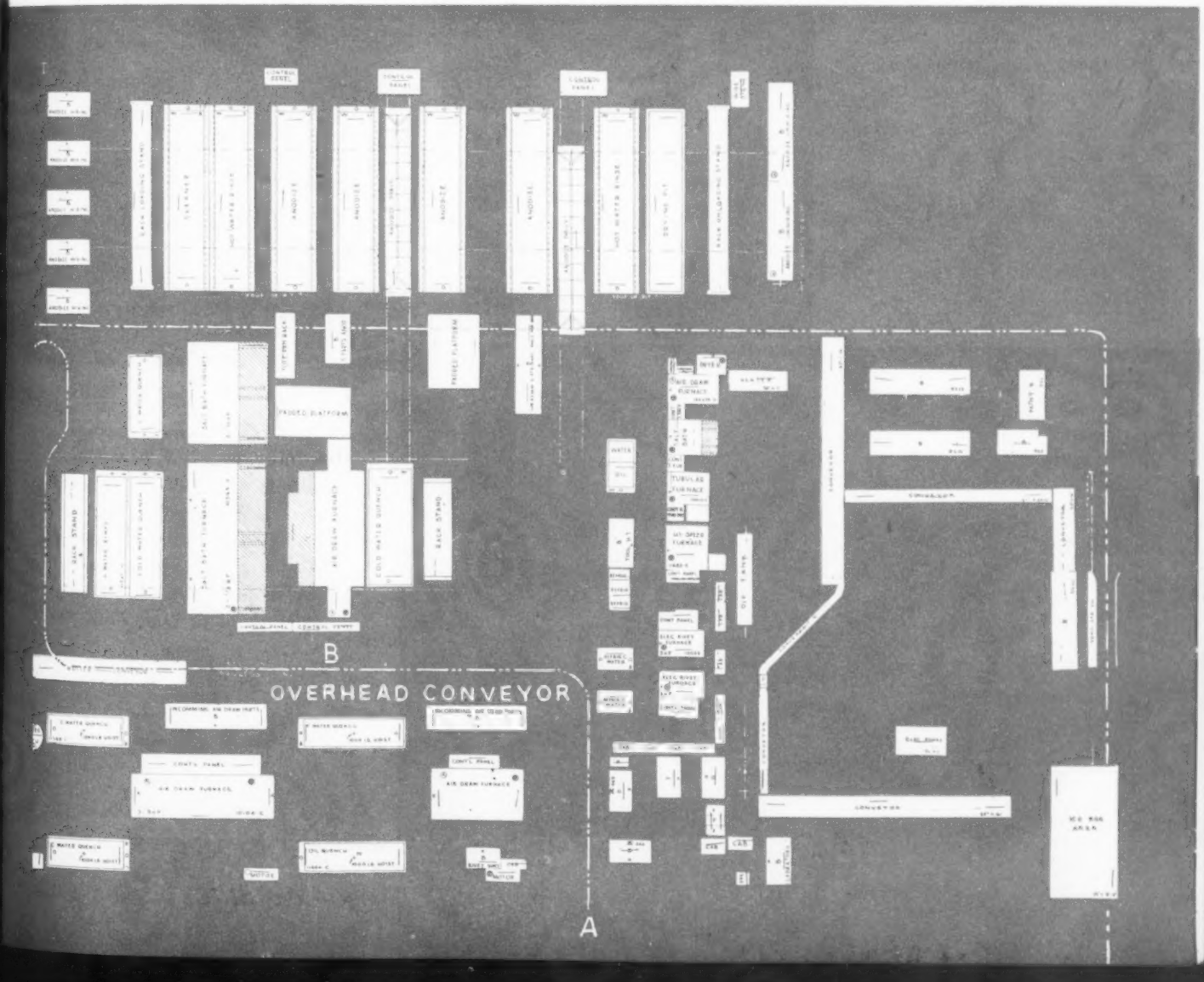
Here, again, a stabilized crane hoist is used, so that the racked parts can be quickly raised and lowered without any sidewise movement which might cause them to touch each other or the sides of the tank, as shown in Fig. 5. This crane moves the pieces to be anodized from the hot water rinse to one of the four anodizing tanks, and then on to the second rinse tank and the drying pit.

Large pieces that cannot be brought into the heat-treating department on the process conveyor are handled on trucks. Two dollies may be rolled out from between the anodizing process tanks for loading these large parts. After being placed on racks, the parts are rolled back under the stabilized hoist for transfer to the initial rinse tank. The use of this single stabilized crane, which handles racks with 1500-pound loads, enables one woman operator to keep eight anodizing process tanks in use continuously.

Also located at this end of the heat-treating department is the heat-treating and refrigerating equipment for rivets, as well as several small heat-treating units used for tools. The paint spraying department is at the extreme right.

Pieces that are to be plated enter the heat-treating department on another process conveyor at point *D*, Fig. 1. They are unloaded at point *E* on the adjoining roller conveyor. If they are ready for immediate chrome-plating, they may be placed in the plating tank shown in Fig. 4. This tank has ten compartments, each of which is connected to a separate copper oxide rectifier with individual sets of controls, as shown at the rear of the illustration. With this arrangement, ten plating jobs, each requiring

Heat-treating Area, Electroplating Area, and Aluminum Heat-treating and Anodizing Areas



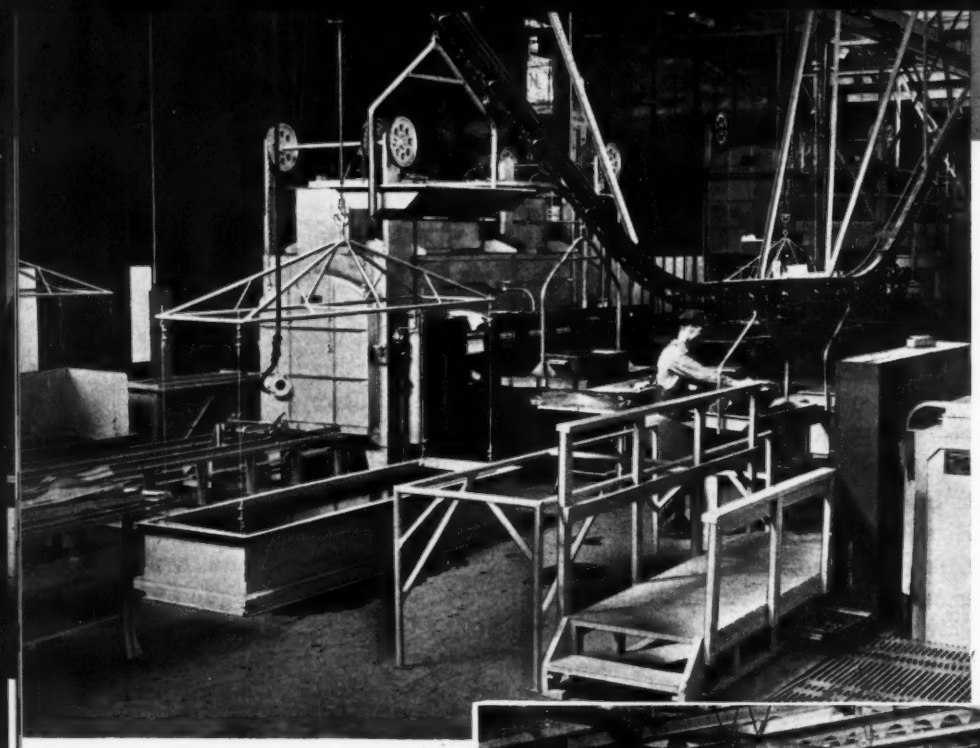


Fig. 2. (Left) Aluminum Parts Arriving on an Overhead Conveyor are Unloaded and Put into a Horizontal Air Draw Furnace at the Rear or into a Vertical Air Draw Furnace or Salt Baths at the Right (Not Shown)

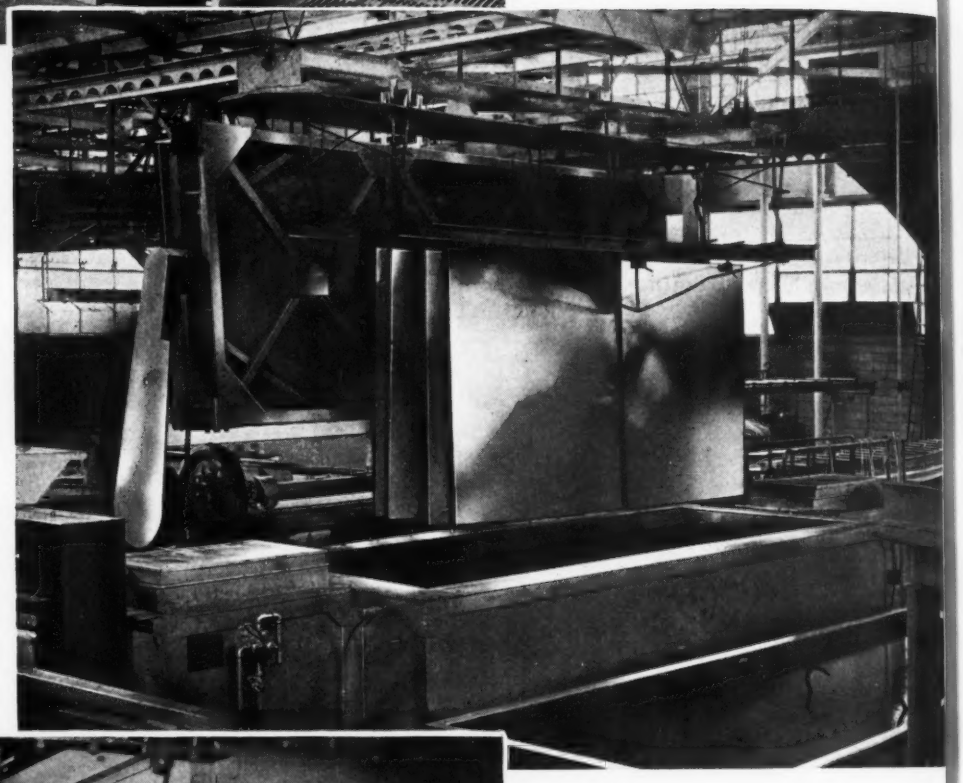


Fig. 3. (Right) Aluminum Sheets for Motor Cowling being Loaded into Vertical Air Draw Furnace by Overhead Stabilized Crane. Door Opens away from Furnace to Protect the Operator

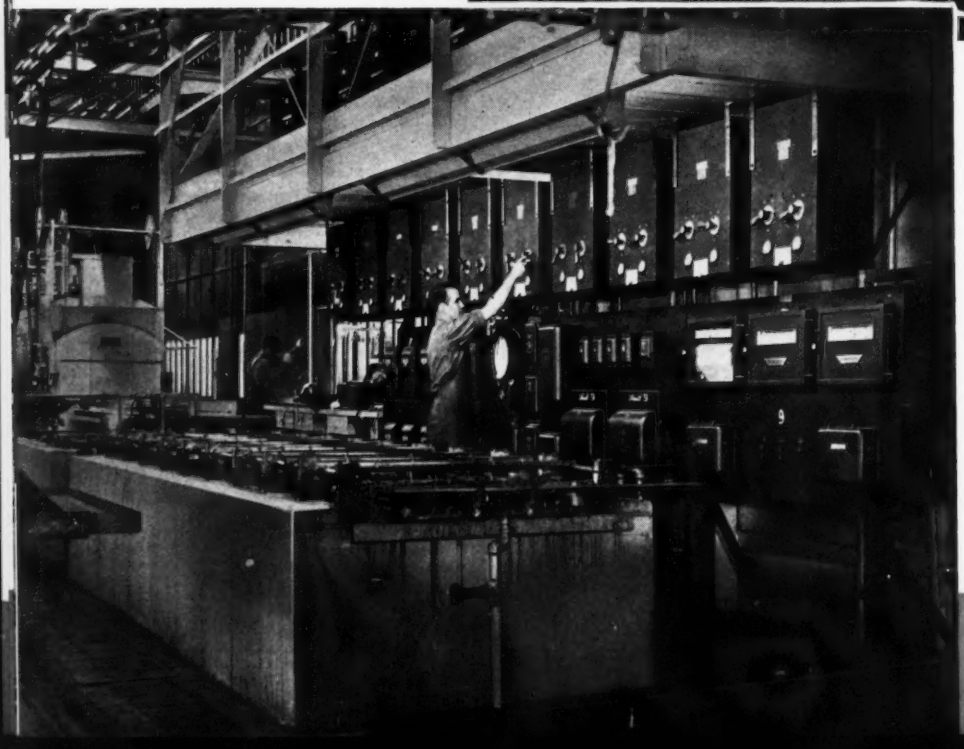


Fig. 4. (Left) Hard Chrome-plating Tank has Ten Sections Connected to Separate Rectifier Units, so that Ten Plating Operations with Different Current Requirements can be Conducted at One Time

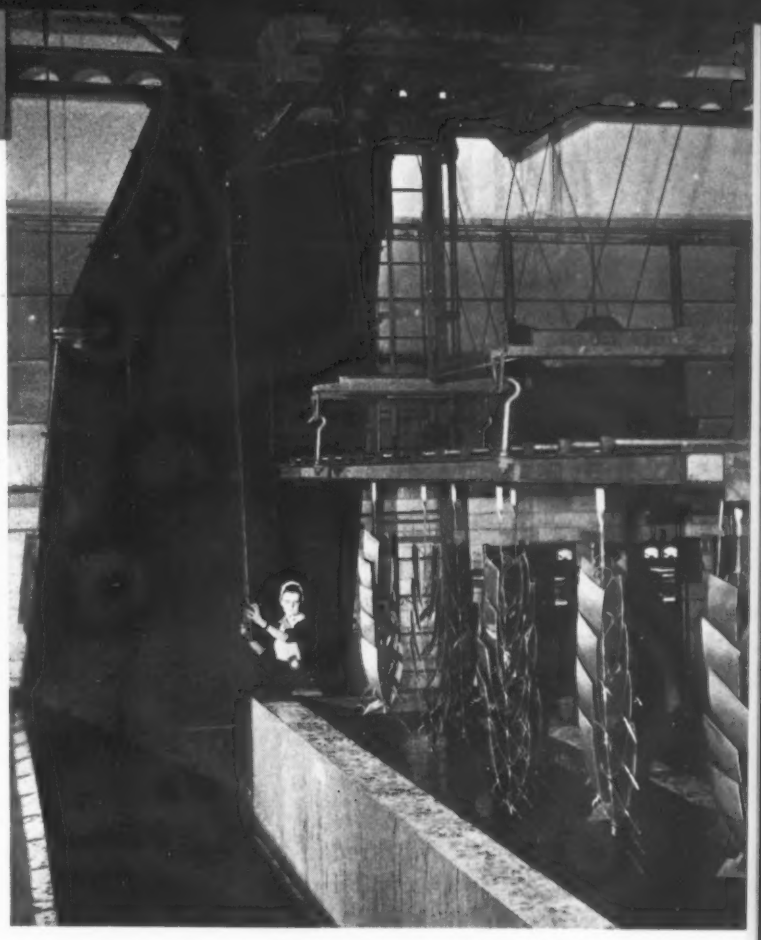


Fig. 5. Parts being Lowered into Anodizing Tank by a Stabilized Crane, which Imparts No Sidewise Movement to Load during Raising or Lowering

different current densities, can be carried on simultaneously.

Pieces that need preliminary processing before chrome-plating are raised or lowered into the successive plating tanks by a monorail hoist, which moves along a track that extends down one side of the inner plating line and up the other, as shown in Fig. 1.

Another monorail hoist runs over the outer plating line and serves to convey parts that are passed through the cadmium- or zinc-plating processes.

A large and well equipped steel heat-treating section includes four Bellevue oil-fired furnaces, three pit type Lindberg Cyclone furnaces, one Ajax-Hultgren electric salt bath furnace, one Lindberg Hydrizing furnace, two Lindberg box furnaces, and a Hevi-Duty high-speed electric furnace. An overhead hoist runs along the line of quench tanks which face the heat-treating furnaces. Two branches from the main track permit heavy parts to be conveyed directly to two of the oil furnaces.

Heavy forgings, such as the landing gear cylinder shown being inserted into one of the oil-fired furnaces in Fig. 6, can be easily handled with the aid of the overhead hoist. Formerly, large cylinders had to be placed in the furnace by hand. This was both tiring and difficult, since these forgings weigh about 65 pounds apiece. Now, with specially designed holding tongs suspended from the hoist, as shown, the handling of these forgings is a relatively simple matter. This arrangement has greatly facilitated the movement of steel parts through the heating and quenching operations.

Another improvement in the heat-treating department has increased the movement of parts through inspection and sand-blasting operations

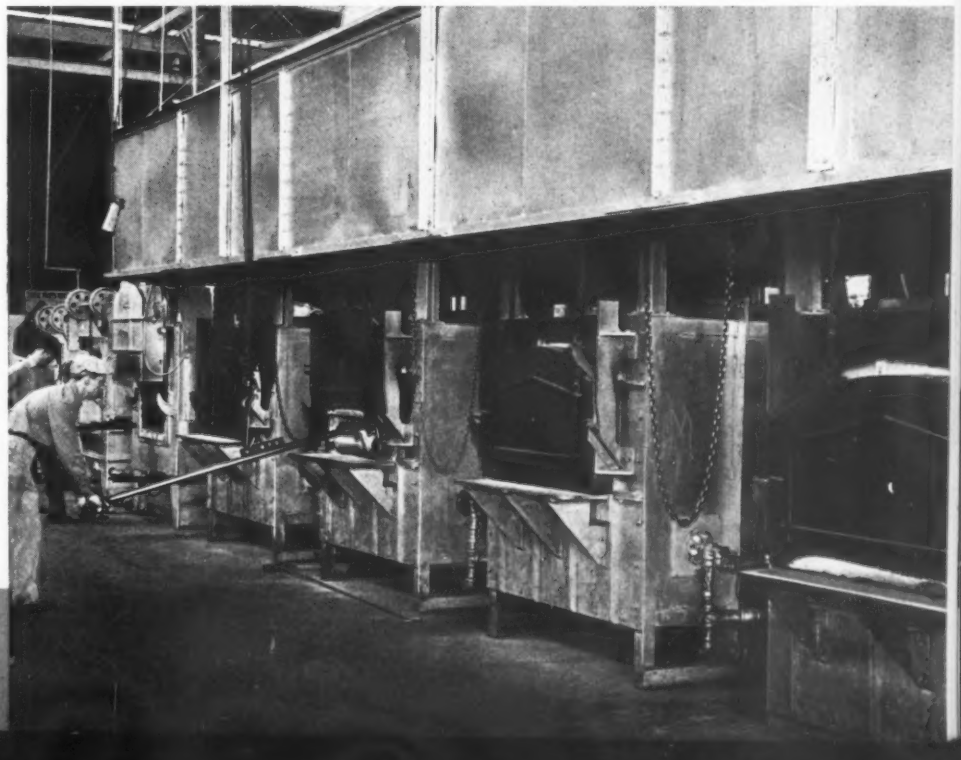


Fig. 6. Line of Oil and Electric Steel Heat-treating Furnaces. Operator is Using Specially Designed Tongs, Connected to an Overhead Monorail, for Placing the Piston Forging in Oil-Fired Furnace

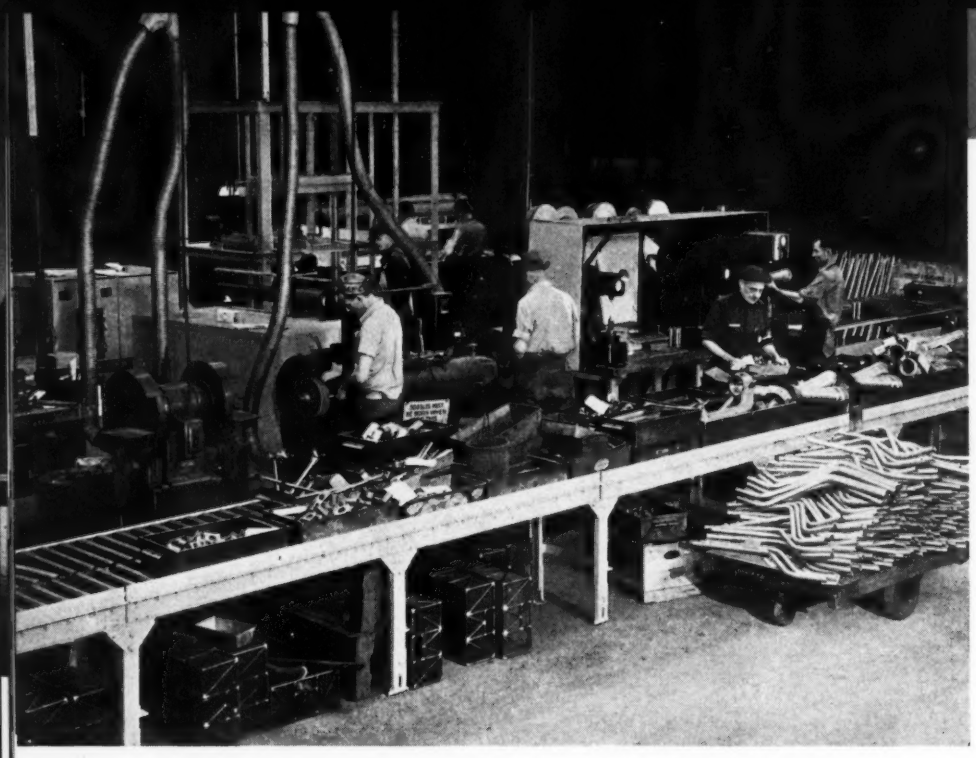


Fig. 7. Roller Conveyor Line for Hardness and Magnaflux Inspection. Two Men in Center are Preparing Parts for Hardness Testing on Rockwell and Brinell Machines Shown Farther down the Line

by 50 per cent, with a 10 per cent decrease in the number of workmen. This improvement is in the nature of a roller conveyor, which carries the parts through the various operations in a definite sequence. This conveyor is shown at the left in Fig. 1. A great deal of congestion has been relieved by this arrangement and all parts must now pass through the hardness inspection first, so that there is no possibility of this operation being missed.

In Fig. 7, workmen are shown grinding flats on parts to be tested for hardness on the two Rockwell and one Brinell testing machines shown farther down the conveyor line. After hardness testing and numbering, parts pass along the conveyor and through a partition into the sand-blasting area. Here they can be quickly placed in one of the several shot- or sand-blasting machines available. An overhead monorail hoist is also provided in this area for transferring heavy parts from the conveyor to the sand-blasting machines.

As the parts move up the other side of the conveyor line, they come to the Magnaflux station, where they are removed and magnetically tested for flaws and cracks. After being placed back on the conveyor line, they are dropped down through an open section into a degreasing tank, and are then placed back on the conveyor to pass through a demagnetizer, as shown in Fig. 8. When the inspection has been completed, the parts are reloaded on the process conveyor at point *E*, Fig. 1, and are passed on to subsequent finishing operations.

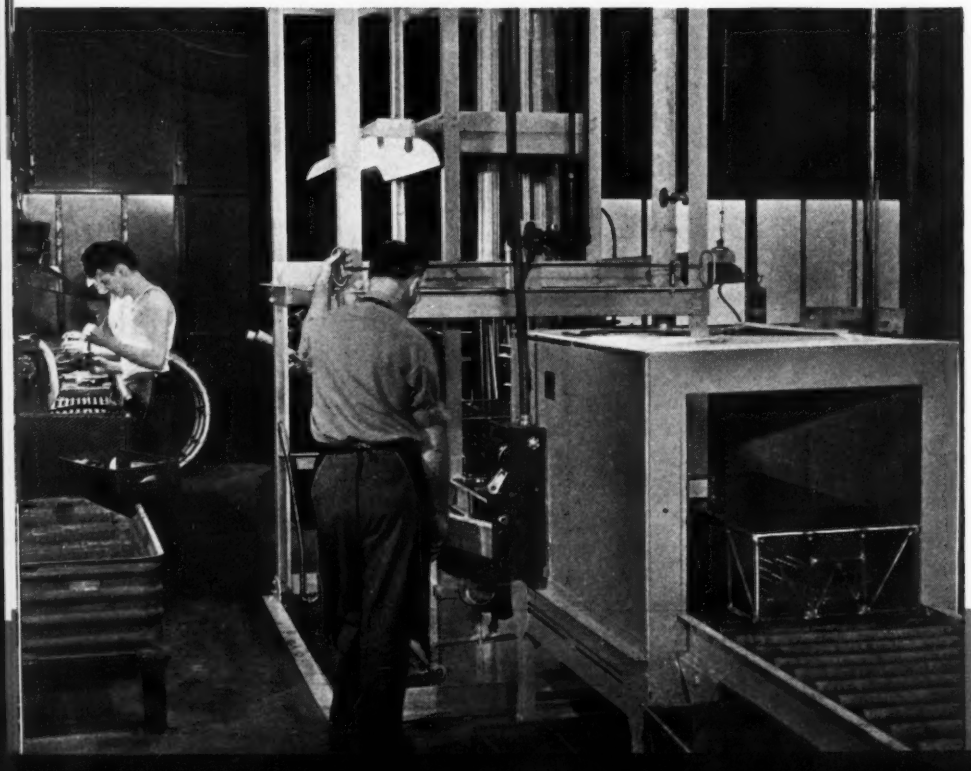


Fig. 8. Two Operators at Left are Using Magnaflux Machine. Operator in Center is Lowering Section of Roller Conveyor with Basket of Work into the Degreaser. At Right, Basket of Work is Going through Demagnetizer

Engineering News

Electric Power Stations on Wheels

Even electric power stations are being placed on wheels in this war of mobile equipment. An electric generating station mounted entirely on railroad cars has been designed by the Westinghouse Electric & Mfg. Co., and a number of these power trains are now being built. Each train is capable of generating 5000 kilowatts; later some twenty trains of 1000-kilowatt capacity will be constructed.

In the larger power trains, consisting of eight railroad cars, turbines, generators, pumps, boilers, and even the living quarters for the crew are mounted on the railroad cars. These mobile power stations are intended to restore electric service in towns and cities that are reconquered by the armies of the United Nations.

Vibration Indicator Used to Inspect Roundness of Commutators

An extremely rapid and accurate method of checking the roundness of motor commutators is employed at the Schenectady plant of the General Electric Co. This method involves the use of a vibration-displacement indicator, the design of which has been slightly altered to meet the requirements of this application.

This instrument, which indicates variations in roundness up to 0.00025 inch on commutators in motors running at high speed, is a small, flat, triangular-shaped instrument with a projecting stylus. For this application, the conventional stylus, which has a pointed end, is replaced by one with a rounded end, and a weaker spring is substituted for the one that ordinarily actuates the stylus. This is done to prevent the stylus from scratching the surface of the commutator. The indicator is mounted on a short metal bar which serves to hold it firmly against the commutator.

In operation, as the stylus is moved toward the commutator, a piece of thin paper is inserted between the two to further protect the commutator. As the stylus follows the vibration of the rapidly rotating commutator, it moves longitudinally in and out of the instrument. This movement is transmitted to a small pivoted mirror, which reflects a spot of light back and forth on the rectangular scale of the instrument. The length of this oscillatory light path on the scale, which is calibrated in easily read divisions of 0.001 inch, accurately indicates any variation in the roundness of the commutator.

New Allison Aircraft Engine Claimed to be Most Powerful in World

The most powerful aircraft engine in the world, which will increase the engine power of the majority of single-engine aerial fighters by several hundred horsepower, has been developed by the Allison Division of General Motors. The new engine has a maximum rating of approximately 3000 H.P. It is a twenty-four cylinder liquid-cooled engine having exactly twice the piston displacement of the present Allison twelve-cylinder engine which is used for such well-known American fighting planes as the Lockheed Lightning, the Mustang P-51, the Invader A-36, the Airacobra, and the Warhawk. Early mass production of the new engine is assured, owing to the fact that in this new motor, 97 per cent of the power producing parts are interchangeable with those used in the present Allison engine.

Shop Operation Heating by Infra-Red Units

A new method of quick heating for shop operations is available to industry in the form of a hand-model "Near Infra-Red" lamp unit brought out by the Fostoria Pressed Steel Corporation, Fostoria, Ohio. This heating means can be applied to metal objects of small area. It develops a relatively high temperature in a very brief period of time—from seconds to a few minutes. For instance, parts made from 20-gage sheet metal, 1 1/2 inches in diameter, can be heated to 1000 degrees F. in 1 1/2 minutes, if the edge of the reflector is spaced 2 1/2 inches from the metal. The heating unit is applicable to some types of soldering operations, preheating materials for various operations, heating small metal parts to secure shrink fits, drying off moisture, etc.

Editorial Comment

A great deal has been said and written about employment in the post-war years; but comparatively little has been said about the most fundamental basis for such employment. Jobs are plentiful when there is ample capital to be invested in industry to create new jobs. It is well known that it takes an average of $5000 of investment in buildings and equipment to employ one man. In some of the high-production industries, it takes up to $9000. Hence, to maintain a high level of employment there must be investments in industry both for the expansion of older plants and for the starting of new enterprises. From where is this capital coming?

Steady Employment is Created through Capital Investment

The present high corporation and income taxes, necessary though they may be, shut off the most important source of new capital that has flowed into industry in the past. Persons with medium and large incomes in the past had a sufficient surplus to invest. That is no longer true. Many people in these income classes are cut down by the present taxes to an expendable income that is not even sufficient to maintain the standard of living to which they have been accustomed. Hence, it cannot be expected that they will be in a position to make new investments. Corporations have been so curtailed through surtaxes and renegotiation proceedings that they have no surplus or reserves available for reinvestment. In fact, many will have difficulty in financing the reconversion to peace production because of insufficient reserves; this, in turn, will make for a scarcity of jobs.

Where, then, is the capital to come from for expansion and for the creation of new enterprises to provide a high level of employment? Is it to be supplied by the Government? But Government has no income except what is collected from individuals, industry, and business through taxation. The Government creates nothing, produces nothing, adds nothing to the capital structure of the nation. It is supported and maintained, for necessary purposes to be sure, by the taxes paid by the people who work and produce and by the businesses whose managements create new products and new possibilities for employment.

Government Creates No Funds with which to Provide Jobs

The Government, when it supplies capital to industry, is merely using the money that would have flowed directly into industrial investment if it had not been taken from business and individuals in the form of taxes. That money first passes into the hands of the Government and then is passed back again, always with the necessary deductions for Governmental administration. It is equivalent to Brown lending Smith some money in order that Smith might be able to lend money to Brown.

There are two constructive methods that can be applied. First, all Government operations must be conducted as economically and free from waste as possible, so that taxation may be reduced to a minimum; second, the taxes that are collected should be of a character that will reduce as little as possible the reservoirs that normally supply industry with its capital, and that thereby maintain employment.

Industry Must Have Ample Reserves for Reconversion

Business and industry should be permitted to create sufficient reserves to meet the day of reconversion to peacetime production. Individuals in the medium and higher income brackets should not be taxed so heavily that there is nothing left for investment in industry—that is, investment in employment. A government that maintains a tax policy that prevents the accumulation of industrial capital is also a government that deals a knock-out blow to steady industrial employment.

★ ★

If any part of our people want to be wards, if they want to have guardians put over them, if they want to be taken care of, if they want to be children, patronized by the Government, I am sorry, because it will sap the manhood of America. But I don't believe they do. I believe they want to stand on the firm foundation of law and right, and take care of themselves.—*Woodrow Wilson in his Inaugural Address, 1913*

Grinding to Ten-Thousandths Inch on a High-Production Basis

Methods and Equipment Used for High-Production Grinding of Work that is Held to Size within Tenths of a Thousandth of an Inch—Last of Three Articles

By RALPH PRICE, Chief Designer
Landis Tool Co., Waynesboro, Pa.

METHODS and equipment developed for precision grinding at high production rates were described in the first installment of this series in April MACHINERY, page 154. Conditions likely to cause inaccurate grinding and suggestions for avoiding or correcting them were explained in May MACHINERY, page 158. The present, and last, installment of this series continues with a further explanation of the causes of inaccurate grinding and their correction.

If visual sizing devices, which gage directly from the work during grinding and thus size the work automatically, are used only for the sizing of simple, straight cylindrical pieces which offer no obstacles, they are not being used to their full advantage. By exercising a little ingenuity, it is possible to apply the sizing devices to a variety of gaging and measuring problems.

Although exactly the same conditions and problems may never arise in other plants, the examples given here suggest how a variety of gaging problems can be solved. The long, thin piece shown at *A*, Fig. 1, is, for the sake of high production, being ground by the straight in-feed method with a wheel as wide as the piece is long. With such wide-faced wheels, the total pressure between the wheel and work is considerable—so great that without support such a piece would almost certainly be sprung and accurate grinding to shape and size would be impossible.

Under these conditions, the work is supported at each end by a work-rest. A visual sizing gage opposite each work-rest enables the operator to adjust both work-rests with great accuracy when setting up the work, and, of course, they give him a constant check on the diameter of each end during grinding. The third gage is used to initially locate the work laterally in relation to the wheel.

In Fig. 2 is shown a part similar to a steering knuckle, which is being ground on two diameters simultaneously with two wheels. Two visual sizing gages, fastened together, are used, one for each diameter. This is necessary in order to detect inaccuracies in the relative diameters of the two sections due to possible unevenness of wear of the grinding wheels.

A diameter and the adjoining shoulder on an airplane engine cylinder are ground with the wheel-base set at an angle, as shown in Fig. 3. In shoulder grinding of this sort—a very com-

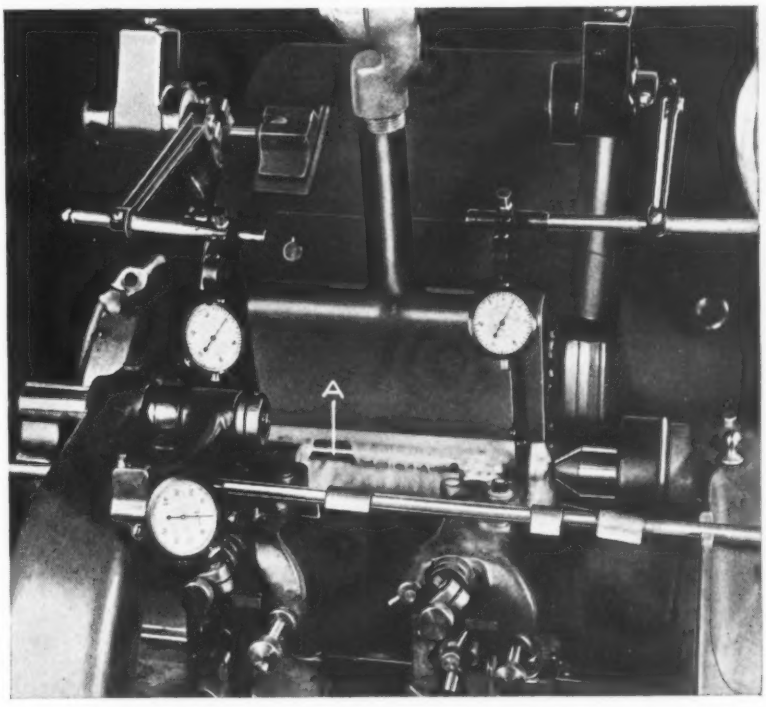


Fig. 1. Sizing and Locating Gages Used in Grinding Long, Thin Piece with Straight In-feed of Wide Wheel

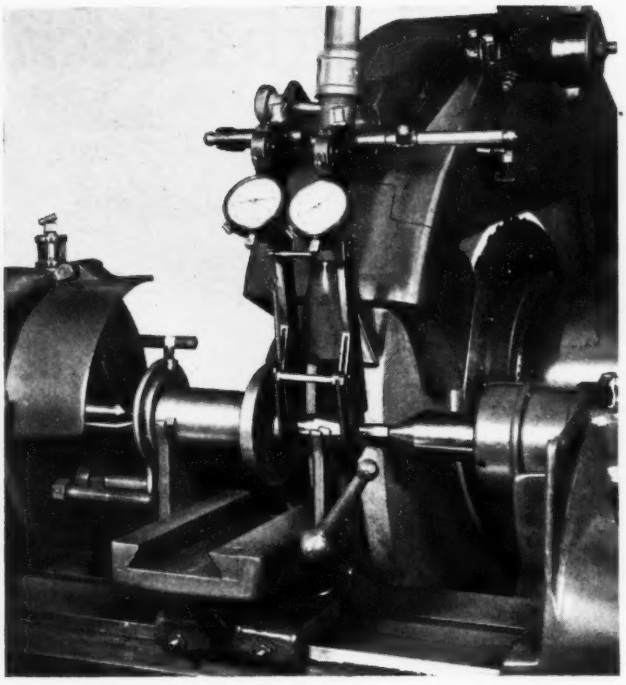


Fig. 2. Set-up for Grinding Two Diameters Simultaneously, Using Two Wheels and Two Visual Sizing Gages

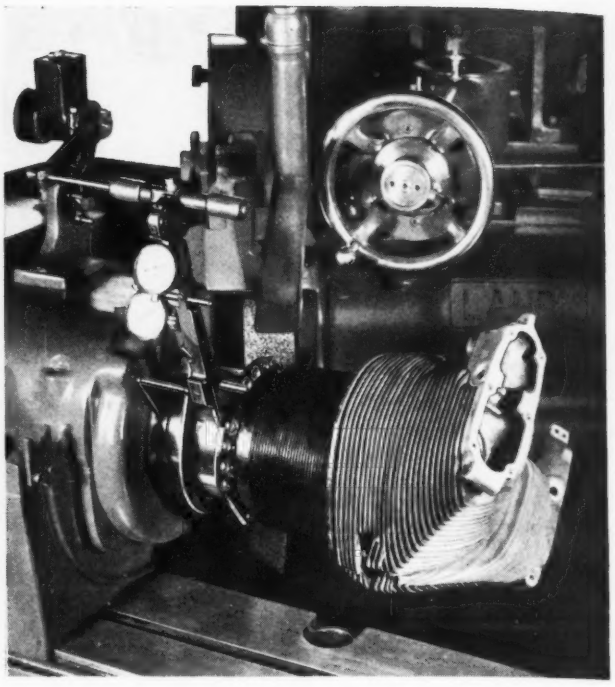


Fig. 3. Grinding a Diameter and Adjoining Shoulder on an Airplane Engine Cylinder with Wheel-base Set at Angle

mon operation—it is necessary not only to hold the diameter within proper limits, but also to keep the face of the flange a certain distance from some predetermined locating point within close limits. In this instance, the locating point is a conveniently located flange at the rear of the work-holding fixture. One of the visual gages gives a running record of the diameter, while the other shows when the face of the flange on the cylinder has been ground sufficiently.

Another interesting example of gaging a diameter and adjoining shoulder simultaneously is shown in Fig. 4. The operation consists of grinding the diameter and adjoining shoulder of an airplane engine crankshaft. To make certain that the face of the shoulder will be properly positioned with reference to the rest of the part, the gaging of the shoulder is done with relation to a hardened steel pin held in the bracket which extends up from the bed in front of the wheel.

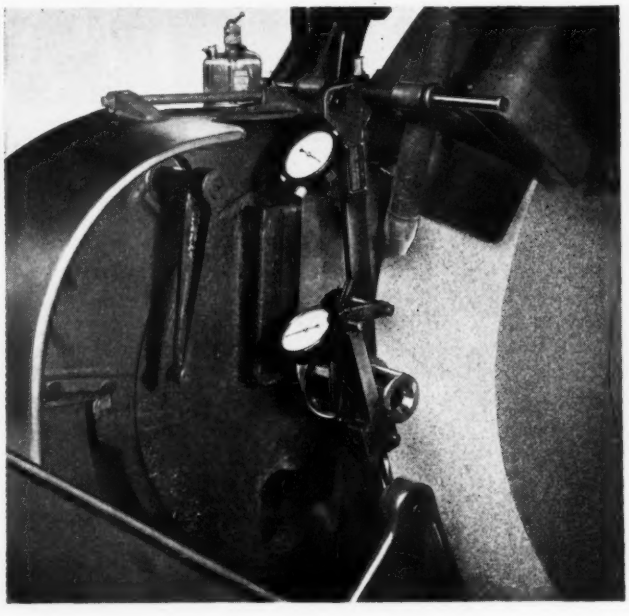


Fig. 4. Equipment for Grinding and Accurate Gaging Operations on Airplane Engine Crankshaft

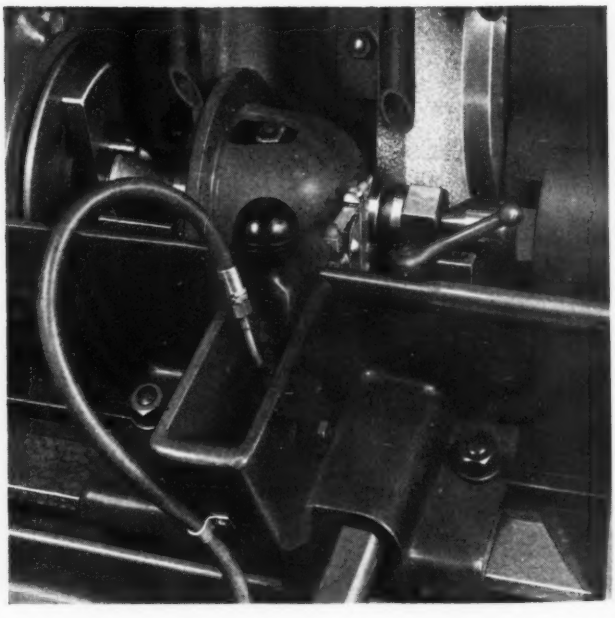


Fig. 5. Set-up for Grinding Two Differential-case Journals Simultaneously with Two Wheels

Incidentally, visual sizing gages used for work held in a chuck play an important part in positioning the work when it is being loaded. Experience has shown that, in the great majority of cases, production can be doubled by this means through the time saved in positioning the part.

Two differential-case journals, Fig. 5, are being ground simultaneously with a two-wheel set-up. Since both journals are the same diameter, only one sizing device is used.

The puzzling problem of assuring the dimensional relationship of adjoining surfaces of the part *A*, Fig. 8, to very close limits was solved with the air-operated Landis-Solex sizing device shown in Fig. 7. The part is a very small roller-bearing ring, the raceway of which has already been ground. The diameters of various pieces when they come from the raceway grinder naturally vary a few ten-thousandths inch from each other. That is not important, but it is extremely important that the two adjacent diameters be held in very close relationship to the actual raceway diameter. Any slight plus or minus inaccuracy in the raceway will be reproduced on the adjacent diameters.

Obviously, here is a case where the usual practice of gaging from the diameter to be ground is not applicable, for while close tolerances could be maintained, it would not follow that the vital relationship would be secured. To meet this condition, the gaging device was altered, so that while the caliper frame rides on the smaller of the two diameters being ground, the air outlet which governs the wheel in-feed is against the raceway. Automatically, and at a high production rate, all raceway diameter variation is thereby duplicated on the two diameters. It will be noted that both adjoining diameters are ground simultaneously by means of a formed wheel.

Four main camshaft bearings are shown in Fig. 6 being ground on a 10- by 36-inch plain hydraulic grinder. Four Landis-Solex sizing devices are employed, one for each

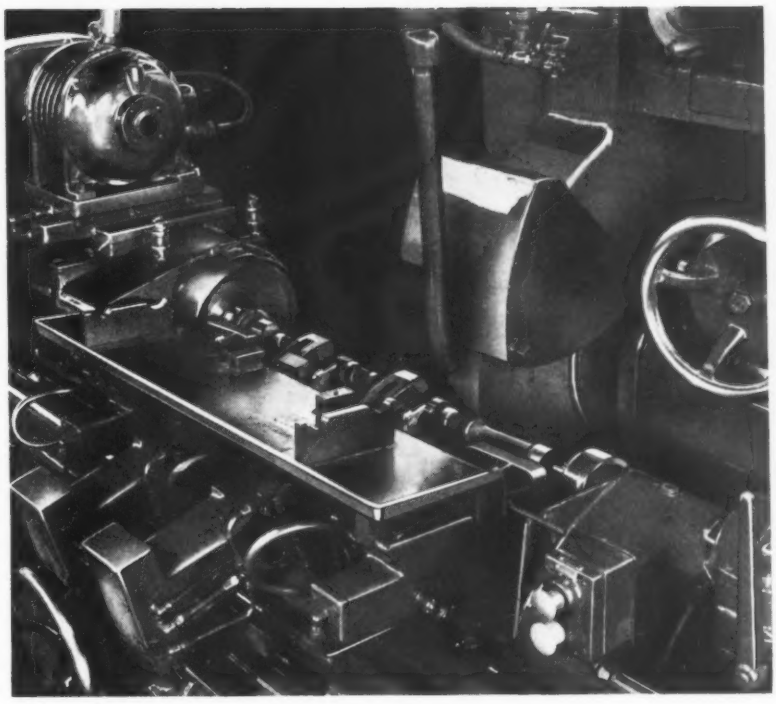
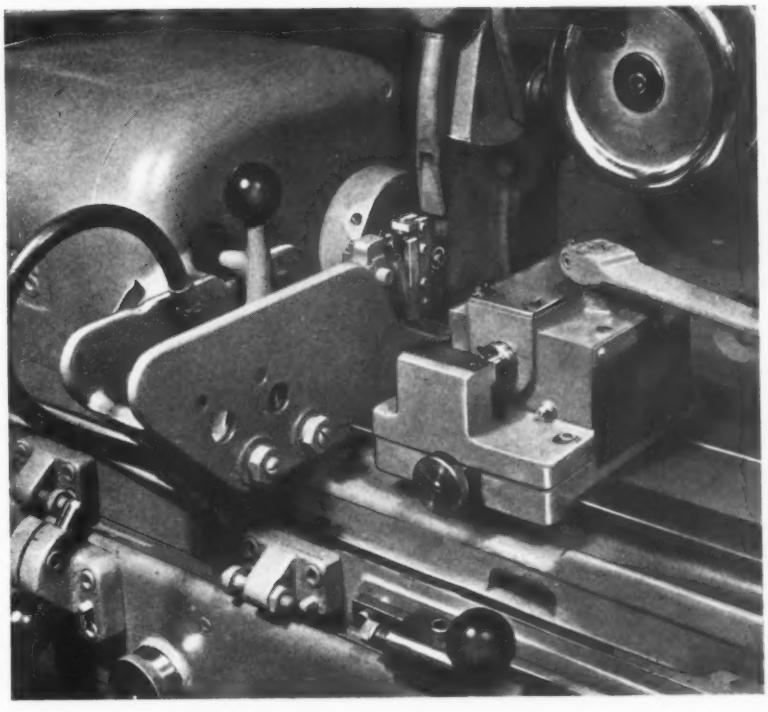


Fig. 6. Plain Hydraulic Grinder Equipped with Four Landis-Solex Sizing Devices for Complete Automatic Grinding of Four Main Camshaft Bearings

Fig. 7. Grinding and Gaging Equipment Employed in the Production of Small Roller-bearing Rings like the One at A, Fig. 8



bearing. This enables the grinding cycle to be completely automatic. Once the work is loaded and the main control lever thrown, all four bearings are ground to size successively without further attention from the operator.

The inner raceway of a double-row outer race is ground on a raceway grinder equipped as shown in Fig. 9. For inner diameters, the automatic air-operated sizing device is equipped with a diamond-tipped sizing finger which rides lightly on the raceway during the entire grinding operation. It has up and down motion under spring tension. The air gap is between the finger-supporting arm and the air outlet, which is on the stationary arm of the sizing head. As the finger moves upward during grinding, the size of the air gap changes, operating a mercury switch and solenoids, as in the conventional device used for cylindrical grinding.

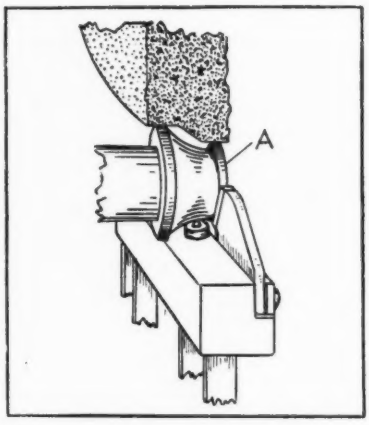


Fig. 8. Method of Grinding and Gaging Small Roller-bearing Ring with Equipment Shown in Fig. 7

The inner raceway of an exceedingly small outer race is ground on the machine shown in Fig. 10. The internal grinding of small diameters such as this presents serious difficulties in sizing. For one thing, it is not possible to govern the feed by gaging directly from the part, as is done with the larger race shown in Fig. 9, because the small diameter prevents the inserting of a sizing finger while the grinding is going on. At the same time, it is especially necessary to have close control over the sizing of these small internal diameters, since the small wheels that must be used wear much more rapidly than the larger ones, and tend to break down ununiformly. The sizing device that was finally developed for this job does not size directly from the piece being ground, as is usual, but from the preceding piece finish-ground by the machine.

At the end of the cycle, the operator unchucks the finished piece, chucks a new piece, places the newly ground piece in the sizing device shown in the right foreground of Fig. 10, and starts the grinding cycle. The sizing device thus controls the size of each piece by compensating automatically for any slight error found on the race previously ground. It compensates for variation in the amount of stock which has to be removed, for variation in the groove concentricity with the outside diameter, for variation in the grinding wheel from wheel to wheel, and for grinding wheel wear from race to race.

Of course, not many shops grind their own races; but this example should be suggestive to those who encounter any sizing problems that cannot be handled by the standard sizing devices.

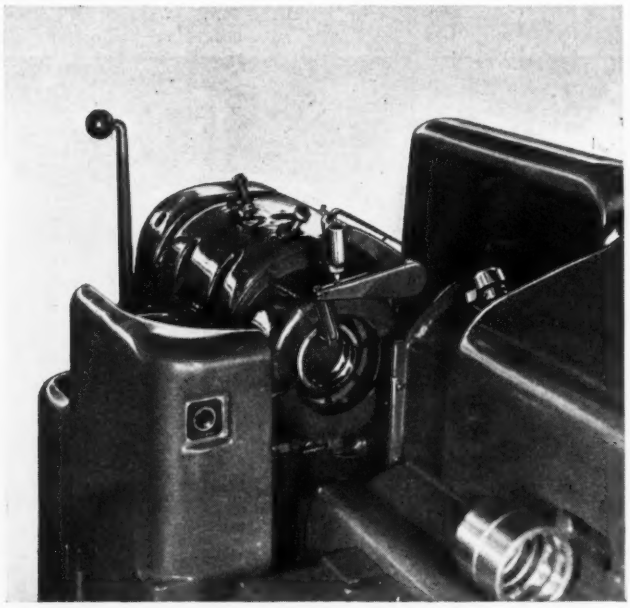


Fig. 9. Equipment for Grinding Inner Raceway of Double-row Outer Race. Air-operated Sizing Device Having Diamond-tipped Finger is Used in This Operation

Fig. 10. Equipment for Grinding the Inner Raceway of a Very Small Outer Race which Employs the Previously Finished Piece for Sizing the Piece being Ground

Gear Manufacturers Elect Officers

Louis R. Botsai, New President of the American Gear Manufacturers Association

Paul W. Christensen Elected Vice-president of the Asso-tion at the Annual Meeting

Raymond B. Tripp, Newly Elected Treasurer of the American Gear Manufacturers Association

AT its annual meeting late in May, the American Gear Manufacturers Association elected the following officers: President, Louis R. Botsai, manager, Gearing Division, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.; vice-president, Paul W. Christensen, president, Cincinnati Gear Co., Cincinnati, Ohio; treasurer, Raymond B. Tripp, vice-president, Ohio Forge & Machine Corporation, Cleveland, Ohio.

The following new members were elected to the executive committee for three years: W. L. Schneider, vice-president, the Falk Corporation, Milwaukee, Wis.; A. H. Candee, mechanical engineer, Gleason Works, Rochester, N. Y.; C. R. Staub, chief engineer, Michigan Tool Co., Detroit, Mich.; and J. W. Hertzler, manager, Worm-gear Division, DeLaval Steam Turbine Co., Trenton, N. J.

Unique Course in Impact Die-Forging

A COURSE in drop-forging, now frequently and more correctly called "impact die-forging," intended for technical and engineering schools, has been prepared by the Chambersburg Engineering Co., Chambersburg, Pa. The text covering this course has been developed in a unique manner. Instead of containing long chapters with elaborate descriptions, the manual consists to a large extent of illustrations and diagrams, which, together with brief explanatory text matter, give a clear conception of the principles of impact die-forging. At the same time, the course meets the requirements of most engineering schools in regard to the number of study hours that can be devoted to the subject in a crowded curriculum.

This text should prove a most valuable guide for the teacher of manufacturing processes. If he wishes to do so, he can elaborate on the subject matter at will; and if time does not permit elaboration, he has at his disposal a most concise, yet complete, statement of the fundamentals of this important mechanical art.

The book is divided into five sections headed as follows: (1) Why a Drop-Forging? (2) The Drop-Hammer; (3) Design of a Drop-Forging; (4) The Drop-Forging Process; and (5) Drop-Forging Manufacturing Tolerances. The text contains, in addition to the explanatory matter, several tables and charts giving important information of value to anyone engaged in the design and production of impact die-forgings.

* * *

The La Guardia Field in New York handles more than 1800 air express shipments a day—over 25 per cent more than a year ago.

Specifying Steel by Performance

By GRESWOLD VAN DYKE
Manager Special Steels Department
Joseph T. Ryerson & Son, Inc.

FOR many years, steel users have been endeavoring to specify steels, especially alloy steels, on a constantly narrower range of analysis. Steel producers have steadily improved their manufacturing methods in an effort to meet these demands. It would, however, be difficult to obtain, on a commercially sound basis, composition ranges narrower than those in use today.

To be sure, the performance of steel is governed in the main by its analysis. "Performance" may be defined as the behavior of steel in relation to machinability, its response to heat-treatment, and its resultant physical properties. Uniformity of performance is one of the most desirable characteristics of any industrially used product; therefore, the specifying of a narrow analysis range has as its objective the procurement of steel that will be uniform in performance.

The control of steel performance by analysis alone, however, is difficult, because all elements entering into the composition of the steel have an effect on its performance—some in one direction and some in another—so that controlling performance through analysis involves a very accurate control of all these elements by the steel-maker. If the steel producer knew the performance requirements of a certain application, and was then merely told the type of steel preferred, he could work to the performance requirements of the customer and be given a larger leeway in chemical analysis.

How a New Method for Determining Steel Performance Came to be Adopted

The scarcity of alloying elements caused by war conditions made it necessary to develop entirely new low-alloy steels to take the place of those previously used that had high percentages of the alloying metals. As there was not sufficient time to check these steels by commercial use, a method had to be adopted to evaluate their performance characteristics by a test that could be quickly and accurately made. The problem was solved by the use of what is known as the "Jominy end-quench hardenability test," which has been applied to a sufficient extent to indicate its reliability in predicting how a steel will perform in commercial heat-treatment practice.

The work done along these lines in connection with the National Emergency Steels has encouraged the idea of specifying steels on a performance basis rather than on chemical analysis only. It is the purpose here to outline briefly some of the important aspects of this subject and to suggest how this method may be generally applied in commercial practice. Since this method of specifying steel has made considerable headway, it probably will be an important factor in the selection and purchase of steel in the future.

Most alloy steels are subjected to some form of heat-treatment before being put to use. Therefore, it is necessary that such steels be purchased with as accurate a knowledge as possible of the manner in which they respond to heat-treatment, or what is frequently called their "hardenability."

Obviously, the hardenability of steel is principally controlled by its analysis. The surface hardness developed by quenching is, in the main, determined by the carbon content, and the depth of penetration of hardness depends largely on the alloy content of the steel, as well as on the inherent grain size.

There are, however, other factors, difficult to identify, which have an effect upon the hardenability. This is evidenced by the fact that two steels of almost identical composition and grain size may have different hardenabilities. The behavior of a specific heat of steel is hard to predict in terms of analysis or of any other controllable factor.

Since, however, steel is purchased for certain requirements, and since certain degrees of hardenability are necessary to make it suitable for a given application, it seems logical to specify the steel on the basis of its hardenability rather than through the indirect route of analysis.

There is nothing new about this method of buying steel to hardness specification. In the early days, before chemical analysis was understood or used, when steel was made by the cementation process, it was actually sold on a hardenability basis. The methods of manufacture in those days were not subject to close control, and it was impossible for the steel-maker to predict just how a certain batch of steel would harden until he had actually tested it. For that reason, steel was sold on a basis of hardenability after being tested for definite applications.

Principle of the Jominy Test

Today we have arrived at what appears to be a logical method of specifying alloy steels on a performance basis. First, we select a certain type of steel, such as a nickel, chromium nickel, chromium molybdenum, etc.; then, instead of specifying a narrow-range chemical composition, we simply require that the steel should have a certain specified degree of hardenability.

Prior to the advent of the Jominy method, hardenability tests took considerable time and were expensive, and most manufacturing plants lacked the necessary equipment to conduct them properly. The Jominy test, however, is simple, easily conducted, and remarkably accurate. A sample of the steel to be tested is machined to approximately 1 inch in diameter and 4 inches in length. Then the sample is heated to its proper quenching temperature, after which it is placed in a fixture and quenched with a jet of water that comes in contact with the bottom end of the sample only.

The result of this quenching method is that the sample is cooled very rapidly at the quenched end, and very slowly at the other end. Between these two extremes, all intermediate commercial rates of quenching are applied to the sample. The rate of quenching is the major factor governing the physical properties obtained by heat-treatment; and by making hardness tests along the length of the quenched Jominy sample, it is possible to determine how the steel will behave at different quenching rates ranging from about 600 degrees per second at the quenched end to 4 degrees per second at the opposite end. Tables have been prepared that give the rapidity with which ground bars of various diameters will cool in different quenching mediums.

In order to determine the effect of quenching on the part being heat-treated, it is only necessary to observe the hardness of the Jominy sample at the joint having the same quenching rate. The hardness of the Jominy sample can safely be assumed to closely approximate that which will be developed on heat-treated parts having the same quenching rate.

In order to pass on to the buyers of steel the advantage of hardenability information, the Ryerson company is now conducting Jominy hardenability tests on each heat of alloy steel before it is placed in stock. From these tests, a chart showing the Jominy hardenability results of the heat in the "as quenched" condition is prepared. The chart also shows the results when the steel is quenched and drawn to 1000, 1100, and 1200 degrees F. These Jominy results are then interpreted for physical properties for 1-, 2-, 3-, and 4-inch round bars at the three drawing temperatures indicated. These results are put on a data sheet, which is sent with each shipment of alloy steel from that particular heat.

This system furnishes the customer a quick, accurate picture of the heat-treatment response that can be secured from the alloy steel received. It is believed that this information will effect a considerable saving of time in the steel-user's plant, as it avoids much experimentation formerly required.

The method of obtaining this interpretation is to harden four Jominy samples in the normal fashion and note the hardness readings on one sample. Then the other three samples are drawn at 1000, 1100, and 1200 degrees F., respectively. After the samples have been drawn, Rockwell hardness readings are taken on each one, and from the data thus obtained the physical properties are determined. The charts referred to also show, on the back, the detailed method of determining physical properties from Jominy tests. It is believed that the method briefly outlined in the preceding paragraphs will be found a practical means of determining just what can be expected from any steel that is to be heat-treated.

* * *

Machine Tool Requirements for 1944

A representative of the War Production Board recently told a meeting of the Machine Tool Industry Advisory Committee that the estimated total machine tool requirements for 1944, including the backlog of unfilled orders, may exceed a value of $600,000,000, as a result of the heavy artillery and other military programs. In order to meet these requirements, the present machine tool production rate must be maintained, and in some instances exceeded. It had formerly been estimated that the shipments for the year would be in the neighborhood of $500,000,000.

A preliminary report of the Tools Division of the War Production Board on idle Government-owned machine tools has also been made public. Up to the latter part of May, war production plants using machine tools have reported about 9200 modern machine tools as idle and available for transfer. This is less than the April rate of shipments of machine tools from machine tool building plants, which amounted to about 10,000 machines.

* * *

According to a service engineer of the Gulf Oil Corporation, a prominent manufacturer of reduction gears for steam turbines was machining 36-inch diameter gears of 8-inch face from S A E 1040 steel. The production and tool life did not seem fully satisfactory. By changing to a recommended cutting oil, the manufacturer was able to increase his production by 40 per cent and the tool life by 150 per cent, in addition to obtaining a materially improved finish.

How to Secure Fine Surfaces by Grinding

By the Late H. J. WILLS
and H. J. INGRAM, Engineer
The Carborundum Co., Niagara Falls, N. Y.

Fourteenth and Last of a Series of Articles Describing the Factors that Govern Fine Surface Quality and the Means by which This Quality Can be Obtained—The Present Article Deals with Lapping Operations as Applied to the Production of Gears and Worms

THE principal reasons for the failure of gears and worms to pass inspection are distortion caused by heat-treatment, chatter and cutter marks, small inaccuracies in tooth profile and tooth spacing, and various surface defects that cause undue friction when the parts are in operation. Many of these faults can be corrected by lapping. If it is necessary that the gears run quietly and smoothly, lapping is essential.

Gears can be mounted on an arbor and lapped between centers on a lathe or on a lapping machine, the lapping machine being preferred if the volume of gears produced warrants the expenditure. In some shops, gears are lapped only when they are mounted on their running centers, while other shops lap gears mounted on either closely or widely spaced centers. It is strongly recommended that both hardened and soft gears be lapped in all three positions under a light load, employing both directions of rotation. The load greatly reduces the time that is required for lapping.

The best results will be obtained when the gears are run at the highest speed available short of the point where the lapping compound would be thrown from the gears. Under 800 surface feet per minute, the exact speed used will have no particular effect upon the time required nor the surface produced. At speeds above 800 surface feet per minute, increasing the speed improves the finish but, on the other hand, slows production.

A lapping compound is applied to the gears after they are in motion. It is essential that the entire surface of the gear teeth be moistened, using a brush to apply plenty of compound. Since the lapping compounds used for gears usually cut much more rapidly than those used for other types of lapping, it is not safe to set the lapping time arbitrarily, based on experience with other parts and other compounds. Examine the first few gears at frequent intervals until the required surface quality has been attained, and use that time as the standard for similar gears.

Both hardened and soft gears should be thoroughly cleaned after lapping by brushing or spraying with a suitable cleaning solution. Water is a good solvent for compounds with a soluble oil vehicle and pastes. Kerosene is used for removing compounds with an oil vehicle. Grease vehicle compounds are cleaned with water or kerosene, depending upon the characteristics of the compound.

The methods just described are, of course, for shops having adequate lapping machine equipment for lapping gears on a production basis. If only a few gears are produced now and then, or if for any reason lapping machines are not available, the gears can be lapped together with excellent results, the same as bearings and journals. For such lapping operations, the gears are assembled in their cases. In this method, it is essential that but little compounds be used. It must not flow or even drip from the gears, for if it does, there is danger of its getting into the bearings.

Compounds for Lapping Gears

Because of the great variety of gears and the many variables, such as the position of the tooth bearing, cutter marks, and finish required, it is necessary to have a variety of compounds, each designed especially for a particular job. The compounds best suited to the ordinary lapping of hardened steel gears are as follows:

For general use, employ a silicon-carbide, 150-grit abrasive in a grease vehicle.

For a fast cut on rough gears, use 90-grit silicon carbide in a grease vehicle.

For a smooth finish on large gears, use as an abrasive 220-grit garnet in a grease vehicle.

For a commercial finish on small gears, use 220-grit silicon carbide in grease; and for a smooth finish on small gears, use FF grit garnet in grease.

If hardened steel gears are lapped with soft metallic companion gears, one of the following compounds designed for soft gears should be

used. For fast cuts on gears of mild steel, cast steel, cast iron, and semi-hardened steels, aluminum-oxide compounds with a grease vehicle are recommended. Since the gears must never be allowed to run dry, it is essential to add machine oil now and then.

The general run of gears are lapped with a compound of 150-grit aluminum oxide in a grease vehicle; for all types of fine-pitch gears, use the same compound in F grit; and for very fine or small gears, use the same compound in 1000 grit.

When less stock is to be removed or a smoother finish is wanted, a slower cutting compound, consisting of garnet as the abrasive in a grease vehicle, is used. For gears of coarse pitch, use 150 grit; for average pitch, use 220 grit; and for all fine-pitch gears, FF grit.

Some shops prefer a more liquid compound than those having a grease vehicle, especially when the lapping process is more or less protracted for any reason. For such cases there are special compounds using soluble oil as the vehicle. They can be brushed or poured on the gears. As the gears become dry, water may be applied to the teeth in sufficient quantity to keep them moist. Oil may be used instead of water; but when water is used, the gears can be cleaned with water—which is desirable from the operator's point of view.

Lapping Compounds Suitable for Hypoid and Spiral Bevel Gears

In lapping hypoid and spiral bevel gears on full or semi-automatic lapping machines, the vehicle in which the abrasive grain is suspended must be thin enough to flow readily and, at the same time, have sufficient body to hold the grain in uniform, unchangeable suspension, uniformly separated in all directions. These features are not found in all ordinary oils. Non-fluid oils are sometimes used; but as they are very sensitive to temperature changes and break down rapidly in use, they can be employed only for a short time, and so are expensive.

The following compounds containing silicon carbide suspended in a special oil cut rapidly and impart a good finish. They should be thinned with light mineral oil to the proper flowing consistency. The bath should have unthinned compound added daily.

For hypoid and spiral bevel gears, the following silicon carbide in oil compounds is recommended. A grit of 120 for heavy truck and bus gears; 150 grit for a rapid cut on average gears; F grit for a normal cut on average gears; FF grit for very good surface qualities or where only a little lapping is required; and FFFF grit for hypoids. The gears are washed in the usual way with kerosene.

Lapping Worms and Worm-Gears

Because worms and worm-gears must be free from chatter marks and other surface imperfections, and smooth enough to reduce to the utmost the friction caused by the sliding action between them when in operation, they must be lapped with a fast cut.

If only the worm is to be lapped, it is mounted between centers on a driven spindle. A cast-iron fiber or Micarta lap is made to the same tooth form as the companion worm-gear, mounted on a two-way carriage, and centered with the worm threads. The machine is started, and the compound applied to the worm with a brush while the lap traverses the worm in both directions the full length of the threads.

Another method is to lap the worm and gear together, in which case the gear takes the place of the manufactured lap. For the lapping operation, the worm and gear are placed on the proper centers, and a slight load applied to the gear to prevent backlash.

As with other gears, if production does not warrant the installation of special lapping machines, it is permissible to lap the worm and gear together in their housing, taking the same precaution against using so much compound that there is danger of its overflowing into the bearings. After lapping, the parts are disassembled and cleaned.

In lapping large worms with a lap made up for the job, 220-grit silicon carbide in a grease vehicle should be used. The same compound can be used with a made lap and a fast cut on small worms. For a medium cut on small gears, use F grit aluminum oxide in soluble oil; and for a fine cut, the same compound with FFF grit. In lapping worms and gears together or gears only, use 220 garnet in grease for a fast cut, FF grit garnet in grease for a medium cut, and F grit aluminum oxide in soluble oil for a fine cut.

Transmission gears are usually lapped on National Broach machines with a 150- or 220-grit silicon-carbide grease compound. The 150 is usually preferable. Most of the silicon-carbide compounds have a very rapid cutting action. With use, this action slowly declines. If very old compound is replaced all at once with a fresh batch, the lapping action will change practically instantly. To maintain reasonably constant action, therefore, it is best to add new compound to the old little by little.

* * *

Government and labor leaders can greatly aid in creating more jobs for those who are able and willing to work by stopping their present practice of hampering and penalizing the men who create jobs.

Materials of Industry

THE PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

Stop-Off Paint for Use in Selective Carburizing

A protective coating used as a stop-off paint for selective carburizing in a liquid carburizer has been developed by the Park Chemical Co., Detroit, Mich., under the name "No-Kase." This product is not a ready mixed paint, as the pigment and vehicle are packed separately, to be mixed immediately before use. "No-Kase" is usually applied by brushing, but spraying or dipping may be employed. 201

New Group of Air-Drying Electrical Insulating Varnishes

A group of air-drying, insulating varnishes known as "Speedairbonds," for use in the manufacture and repair of electrical equipment, have been placed on the market by the Sterling Varnish Co., 147 Ohio River Blvd., Haysville, Pa. The new varnishes are said to dry exceptionally fast to a smooth and glossy finish. They are oil-proof and extremely water-, acid-, and alkali-resistant. They also have high dielectric qualities, flexibility, and long life. 202

Combination of Plastics and Glass Provides New Structural Material

Plastics reinforced with glass fibers provide a new structural material differing radically in properties from other materials now in general use. This glass-reinforced plastic for structural parts, already applied to aircraft, was developed by the research laboratories of Owens-Corning Fiberglas Corporation, working in collaboration with the U. S. Army Air Forces. Plastics reinforced with glass fibers provide a material of very high strength combined with low weight—much below aluminum for the equivalent strength.

Plastic glass laminates lend themselves to slender forms, to light-weight construction, to rounded contours, etc. Experimental construction developed up to the present time consists of a sandwich design having a balsa wood core between an inner and outer skin of plastics reinforced with fibrous glass cloth. In tests, it was found that the tensile strength is proportional to the amount of glass in the laminate, the strength varying from about 43,000 to 55,000 pounds per square inch. Compression strengths as high as 56,800 pounds per square inch were recorded. The average specific gravity is 1.75. These values are for cross-laminated glass cloth. It is said that tensile strength values approximately twice those mentioned can be obtained with parallel-laminated cloth. 203

Formex Ribbon Magnet Wire Available as Thin as 0.004 Inch

The General Electric Co., Schenectady, N. Y., has brought out a Formex ribbon magnet wire with a thickness of only 0.004 inch, which is one-fourth the size heretofore considered the low limit for thickness of this type of wire. It is smooth, strong, flexible, and able to withstand high-speed winding without damage to the insulation. It offers many application possibilities to producers of electronic devices and other electric equipment. Because of its thinness, this ribbon wire can be applied where round wire previously had to be used. 204

New Design Resilient Mounting for Instruments, Couplings, etc.

An entirely new type of resilient mounting utilizing cylinders of rubber or rubber-like materials interconnected by arms in "S" fashion has been developed by the B. F. Goodrich Co., Akron, Ohio. This arrangement permits an extremely soft suspension under light load and allows the resilient material freedom of movement in all directions.

The mounting will take care of a variety of stresses, including shear, bending, torsional, or twisting, and permits the material used to be stressed simultaneously under both shear and tension. The invention is valuable in a variety of applications, including the mounting of housings for aircraft compasses and other instruments, flexible power transmission couplings, etc. 205

To obtain additional information on materials described on this page, see lower part of page 214.

Development of the Art of Chromium-Plating Cutting Tools

EVER since the beginning of the war, the tremendous requirements for cutting tools and the scarcity of several of the alloying metals used in both high-speed steel and carbide tool materials have encouraged the application of every available means for prolonging the life of tools. Among the most successful of these methods is chromium-plating.

The principles involved in the chromium-plating of cutting tools are not new, having been applied more than a dozen years ago. As a matter of fact, patents on methods for chromium-plating cutting tools were granted as early as 1926, and were followed by other important patents covering the same subject in 1927, 1931, and 1934. In some of the later patents, all of the methods and precautions that are being used in the chromium-plating of cutting tools today were covered, and have since been successfully applied not only by concerns that chromium-plate cutting tools for the market, but also by several large manufacturers who chromium-plate tools for their own use.

In view of the present wide application of chromium-plating of tools and the greatly prolonged life of the tools resulting from the process, one might ask the question why the process was not more widely applied in the years preceding the war, since the procedure to be followed was fully understood.

Two reasons may be advanced for this. One —and probably the primary reason—is that since there was no scarcity of cutting tools and cutting tool materials, the necessity for the application of the process was not urgent, and it was only in a few instances that the more aggressive concerns that devoted themselves to chromium-plating could persuade users of cutting tools to try tools so treated.

The second reason is that, as with many new processes, chromium-plating of tools had been tried by concerns who did not take the trouble to learn how to chromium-plate them correctly, and some manufacturing plants had come to the conclusion that chromium-plated tools were not satisfactory. This has been the story of practically all new developments. Those whose mechanical experience goes back forty years will remember that, at that time, high-speed steel was pronounced by many to be an undependable material, simply because the methods of hardening high-speed steel were not fully understood. When carbide tools were first introduced, industry passed through the same experience. Many concerns said that carbide tools were of no value, because they tried to apply them in the same manner as high-speed steel tools. Chromium-plated tools have passed through somewhat the same experience.

Today, however, chromium-plating of tools has been demonstrated to be fully successful, provided the chromium-plating is done by men experienced in the art and capable of achieving successful results because of their knowledge and their attention to detail. Throughout the country, there are now many chromium-platers who are regularly furnishing their customers with chromium-plated tools that can be depended upon to give uniformly reliable results. There are also several large manufacturers who have their own plating departments and who are thereby remarkably prolonging the life of many types of cutting tools.

The important thing to take into consideration is that, as with any other art, it is not possible for the inexperienced to achieve the same results as those who have gradually acquired knowledge and skill in how to do this work. Work done by inexperienced people might discourage the use of a process that has proved itself exceptionally valuable when properly applied to the type of tools for which it is suitable. It would be unfortunate if so useful a process should be discredited because of improper application.

* * *

Machine Tool Demand Increasing

According to figures published by the Tools Division of the War Production Board, machine tool shipments in April were valued at approximately $42,150,000. The total net new orders for machine tools (total orders less cancellations) during the month of April amounted to $54,250,000, or at an annual rate of approximately $650,000,000. The backlog of unfilled orders for machine tools at the end of April was valued at $167,000,000, equivalent, at the present rate of shipments, to about four months' production of the industry.

* * *

Agriculture, manufacturing, commerce, and navigation—the four pillars of our prosperity—are most thriving when left free to individual enterprise.—*Thomas Jefferson*

New Trade Literature

RECENT PUBLICATIONS ON MACHINE SHOP EQUIPMENT, UNIT PARTS, AND MATERIALS

To Obtain Copies, Fill in on Form at Bottom of Page 213 the Identifying Number at End of Descriptive Paragraph, or Write Directly to Manufacturer, Mentioning Catalogue Described in the July Number of MACHINERY

Charts for Use with Comparators and Projectors

ENGINEERS SPECIALTIES DIVISION, 588 Monroe St., Buffalo 11, N. Y. Bulletin on charts, scales, and rules for use with all makes of optical comparators and projectors; booklet 103R, "Helping You to Get the Utmost from Your Projection Measuring Equipment"; bulletin on screw thread comparator charts; circular giving specifications and prices for charts for use with optical comparators, projectors, and shadowgraphs. 1

Lubrication

SUN OIL CO., 1608 Walnut St., Philadelphia 3, Pa. Color-print poster entitled "Save and Serve—Serve Your Country; Save Equipment, Productive Time, and Labor with Proper Lubrication;" prepared as part of the company's "Save and Serve with Proper Lubrication" campaign. 2

Lubrication Systems

ALEMITE DIVISION, STEWART-WARNER CORPORATION, 1826 Diversey Parkway, Chicago, Ill. Bulletins entitled: "Progressive Lubricating System for Industry"; "Lubro-Meter Centralized Lubrication System"; "Alemite Dual Progressive System"; and "Dual Manifold System of Lubrication." 3

Tool Reconditioning and Conversion

RUTLAND TOOL SERVICE, 13006 Greeley Ave., Detroit 3, Mich. Folder entitled "Tool Reconditioning and Conversion—What are You Doing with Surplus Tools Left over from Curtailed and Terminated Contracts?" 4

Diamond Tools for Industrial Purposes

WESTCOAST DIAMOND TOOL CO., 11601 Wilshire Blvd., Los Angeles 25, Calif. Catalogue of diamond tools for industrial purposes, including truing tools, dressers, needle-point tools, impregnated grinding wheels, and diamond-charged metal saw blades. 5

Alternating-Current Arc Welders

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Bulletin GEA-4081, descriptive of General Electric alternating-current arc welders and their application on various classes of work. 6

General-Purpose Hydraulic Presses

WATSON-STILLMAN CO., Roselle, N. J. Bulletin 370-A, covering a general-purpose hydraulic press suitable for varied work in the metal-forming, ceramic, and plastic industries. 7

Thread Grinding Machines

COSA CORPORATION, 5000 Chrysler Bldg., New York 17, N. Y. Catalogue on thread grinding machines of high precision, manufactured by the Societe Genevoise d'Instruments de Physique, Geneva, Switzerland. 8

Synthetic Rubber Products

ACADIA SYNTHETIC PRODUCTS DIVISION OF WESTERN FELT WORKS, 4115 Ogden Ave., Chicago, Ill. 70-page book containing technical data on a variety of synthetic rubber products, including extruded parts, molded parts, sheets, rolls, and cut parts. 9

Oil and Grease Absorbents

WAVERLY PETROLEUM PRODUCTS CO., 478 Drexel Bldg., Philadelphia 6, Pa. Bulletin 7, describing some of the many applications of "Speedi-Dri," an oil and grease absorbent, and "Sol-Speedi-Dri," a water soluble oil absorbent. 10

Contract Service

L. F. GRAMMES & SONS, INC., Allentown, Pa. Catalogue describing the contract service facilities provided by this company, as well as the company's regular line of etched metal products, such as nameplates, dials, etc. 11

Electronic Adjustable-Speed Motor Drives

WELTRONIC CO., Detroit 19, Mich. Bulletin WTM-44, describing a new electronic adjustable-speed motor drive for operating direct-current motors from alternating-current power supply. 12

Pre-Finished Metals

AMERICAN NICKELOID CO., Peru, Ill. Catalogues on pre-finished bonded metals, provided in sheet, strip, round-edge flat wire, and plain, striped, corrugated, and crimped forms. A table of typical uses is included. 13

Sump Cleaning Equipment

HENRY EQUIPMENT CO., 305 Bank Bldg., Bowling Green, Ohio. Circular on sump cleaners for quick, convenient removal of chips, sludge, coolant, and cutting oil from machine tool sumps. 14

Sheet-Metal Bender

STRUTHERS WELLS CORPORATION, Titusville, Pa. Bulletin 53-T, illus-

trating and describing the improved Struthers-Wells tangent bender for edge bending sheet metal in the lighter gages. 15

Fasteners for Metal or Plywood Sheets

SIMLOK DIVISION, SIMMONS MACHINE TOOL CORPORATION, 1600 N. Broadway, Albany 1, N. Y. Catalogue entitled "Simlok—the Fastener of Today with the Design of Tomorrow." 16

Hydraulic Milling Machines

CINCINNATI MILLING MACHINE CO., Cincinnati 9, Ohio. Catalogue M-1284, containing description and complete specifications covering Cincinnati 28-inch series, vertical Hydro-Tel milling machines. 17

Electronic Equipment

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Bulletin GEA-4214, describing the G-E electronic relay for controlling the levels of many liquids and for a variety of other control purposes. 18

Carbide-Tipped Cutters

SUPER TOOL CO., 21650 Hoover Road, Detroit 13, Mich. Folder covering the complete line of carbide-tipped plain and side milling cutters made by this company. 19

Vapor Degreasing

PHILLIPS MFG. CO., 3475 Touhy Ave., Chicago 45, Ill. Handbook on vapor degreasing for engineers, production men, and students, arranged in question and answer form. 20

Aircraft Cutting Tools

CLEVELAND TWIST DRILL CO., 1242 E. 49th St., Cleveland 14, Ohio. Booklet containing dimensions and prices of drills, reamers, and counterbores designed for aircraft work. 21

Abrasive Products

CARBORUNDUM CO., Niagara Falls, N. Y. Booklet on "MX" products, an important abrasive tool development with soft, cushion cutting action for unusually broad industrial application. 22

Pipe Thread Gages

PRATT & WHITNEY DIVISION NILES-BEMENT-POND CO., West Hartford, Conn. Circular 477, on ANPT pipe thread gages, describing what they are, what they do, and how to use them. 23

Spring-Lock Fastener

ELASTIC STOP NUT CORPORATION OF AMERICA, Union, N. J. Catalogue of spring-lock fasteners designed for airplane cowling, but also suitable for wide application in industry generally. 24

Chuck Handbook

WESTCOTT CHUCK CO., Oneida, N. Y. Handbook of chucks, written primarily for newcomers to the metal-working industries and students, containing information on construction and use of chucks. 25

Checking Machine for Hobs and Milling Cutters

MICHIGAN TOOL CO., 7171 E. McNichols Road, Detroit 12, Mich. Bulletin 471-44, on resharpening checking machine for hobs, milling cutters, and form cutters. 26

Hardness Testing Equipment

TINIUS OLSEN TESTING MACHINE CO., 530 N. 12th St., Philadelphia 23, Pa. Bulletin 27, describing the complete line of Olsen Brinell hardness testing machines. 27

Glass Surface Plates

GEORGE SCHERR CO., INC., 199 Lafayette St., New York 12, N. Y. Folder on Opti-Flat glass surface plates and other tool-room precision equipment. 28

Cutting Tools

CRUCIBLE STEEL CO. OF AMERICA, 405 Lexington Ave., New York 17, N. Y. Catalogue giving much useful information on Rexalloy cutting tools. 29

Hydraulic Presses

HYDRAULIC PRESS MFG. CO., Mount Gilead, Ohio. Bulletin 4400, describing in detail the operation of the H.P.M. closed-circuit Fastraverse system of press operation. 30

To Obtain Copies of New Trade Literature

listed on pages 212-214 (without charge or obligation), fill in below the publications wanted, using the identifying number at the end of each descriptive paragraph; detach and mail within three months of the date of this issue to:

MACHINERY, 148 Lafayette St., New York 13, N. Y.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Name ..... *Position or Title* .....

[This service is for those in charge of shop and engineering work in manufacturing plants.]

Firm .....

Business Address .....

City ..... *State* .....

[SEE OTHER SIDE]

Bevel-Gear Machinery

BILGRAM GEAR & MACHINE WORKS, INC., 1217-35 Spring Garden St., Philadelphia 23, Pa. Catalogue illustrating and describing bevel-gear generators and chamfering machines. 31

Hydraulic Testing Machines

GREER HYDRAULICS, INC., 39 W. 60th St., New York 23, N. Y. Bulletin describing four types of machines for testing all kinds of production hydraulic devices. 32

Rapid-Finishing Tool Steel

JESSOP STEEL CO., Washington, Pa. Bulletin 743, containing data on analysis, heat-treatment, and typical applications of Jessop Rapid-Finishing tool steel. 33

Engraving Machines

H. P. PREIS ENGRAVING MACHINE CO., 155 Summit St., Newark 4, N. J. Bulletin on Panto Utility engraver for engraving, electrical marking, and acid etching. 34

Shop Trucks

YARD-MAN, INC., Jackson, Mich. Bulletin describing the Model D "Truck-Man," a gasoline-engine operated shop truck for handling materials easily. 35

Spring Washers

NATIONAL LOCK WASHER CO., Newark, N. J. Bulletin on nonferrous Kantlink spring washers made from Everdur, K-Monel, and stainless steel. 36

Precision Measuring Instruments

METRICAL LABORATORIES, INC., 403 Detroit St., Ann Arbor, Mich. Bulletin on the "Metricator," an air-operated precision gage. 37

Drill Presses

• BOICE-CRANE CO., Toledo, Ohio. Catalogue on Boice-Crane 15-inch single- and multiple-spindle drill presses, made in bench and floor types. 38

Temperature Control for Metal Cleaning

SARCO CO., INC., 475 Fifth Ave., New York 17, N. Y. Bulletin 650, on temperature control for degreasers and metal cleaners. 39

Heat-Treating Furnaces

JAMES H. KNAPP CO., 4920 Loma Vista Ave., Los Angeles, Calif. Folder on the Knapp-Lee "Quick-Quench" heat-treating furnaces. 40

New and Rebuilt Machine Tools

J. L. LUCAS & SON, INC., Bridgeport 5, Conn. Bulletin 111S, on new and rebuilt machine tools for quick delivery. 41

Sanders

NATIONAL AIR SANDER, INC., 2712 W. State St., Rockford, Ill. Folder illustrating and describing the new "Mity-Midget" high-speed block sander. 42

Quick-Acting Clamping Devices

GRAND SPECIALTIES CO., 3126 W. Grand Ave., Chicago 22, Ill. Catalogue covering the line of quick-acting clamps made by this company. 43

Fractional-Horsepower Motors

DUMORE CO., Racine, Wis. Brochure entitled "Out of Thin Air," covering developments in fractional-horsepower motor design. 44

Machine Flame Cutting

AIR REDUCTION, 60 E. 42nd St., New York 17, N. Y. Booklet entitled "Machine Flame Cutting for Assembly Line Fabrication." 45

Steel Castings

LEBANON STEEL FOUNDRY, Lebanon, Pa. Booklet entitled "Water Quenching Requirements for Steel Castings." 46

Seamless Steel Tubing

SEAMLESS STEEL TUBE INSTITUTE, Gulf Bldg., Pittsburgh 19, Pa. Bulletin on seamless steel alloy aircraft tubing. 47

Gage-Blocks

FONDA GAGE CO., Stamford, Conn. Bulletin on Fonda "Ultra-Finish" precision gage-blocks. 48

To Obtain Additional Information on Shop Equipment

Which of the new or improved equipment described on pages 215-249 is likely to prove advantageous in your shop? To obtain additional information or catalogues about such equipment, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning machine as described in July, 1944, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Fill in your name and address on other side of this blank.

To Obtain Additional Information on Materials of Industry

To obtain additional information about any of the materials described on page 210, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning name of material as described in July, 1944, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.

Fill in your name and address on other side of this blank.

Detach and mail to MACHINERY, 148 Lafayette St., New York 13, N. Y.

[SEE OTHER SIDE]

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material-Handling Appliances Recently Placed on the Market

"Red-Ring" Gear-Tooth Shaving Machine with Power-Driven Horizontal Table

A precision gear-tooth shaving machine, designed for finishing both internal and external gears with pitch diameters ranging from 12 to 36 inches, has just been brought out by the National Broach & Machine Co., 5600 St. Jean Ave., Detroit 13, Mich. This new "Red Ring" gear-tooth shaving machine, designated the GCQ-36, differs from previous machines of this line in that the work is carried horizontally on a power-driven rotary work-table instead of being mounted in a vertical position. The principle of rotary crossed-axes shaving is incorporated in this machine as in previous gear-tooth shaving machines of the "Red Ring" line.

The teeth of the gear to be finished by shaving mesh with those of the shaving cutter, which is free to rotate. The cutter, driven by the gear being shaved, is slowly reciprocated across the face of the work gear in a direction parallel to its axis. The cutter is fed into the work gear one increment at each reversal of its reciprocating motion. The finished size of the tooth obtained by the shaving operation is controlled by the total amount of in feed during the cycle.

The gear on which the teeth are to be shaved is held in a quick-clamping fixture on the rotary work-table. The cutter-head with its vertical cross-feed slide is mounted on the forward end of the horizontal feed slide. The function of the horizontal slide is to feed the cutter into the work, while that of the vertical slide is to reciprocate the cutter across the face of the work.

After locating the cutter in mesh with the upper ends of the work-gear teeth, the machine is started. As the cutter and work rotate, the cutter-head moves slowly downward at a selected rate of between 0.004 and 0.016 inch per revolution of the work gear. This rate of travel is varied by means of change-gears. On reaching the lower end of the stroke, the table rotation is reversed, the cutter is fed one increment into the work gear, and the cutter-head starts its upward stroke. This automatic action is repeated when the cutter-head reaches the top of its stroke. After several such cutting strokes, depending on the amount of stock to be removed, the in feed is disengaged and the machine idles through one or more additional strokes to assure maximum smoothness of the tooth surfaces, stopping automatically at the end of the idling strokes to permit unloading.

Accidental over-travel of both the vertical and the horizontal slides is prevented by limit switches. A single power unit drives both the work-table and the vertical cross-feed slide, thus maintaining a constant relationship between table speed and cutter feed. Both the table speed and cutter feed can be

Precision Gear-tooth Shaving Machine Brought out by the National Broach & Machine Co.

To obtain additional information on equipment described on this page, see lower part of page 214.

varied over a wide range by means of change-gears.

A central push-button and selector-switch control station is located within easy reach of the operator. An automatic counter can be set to stop the machine at the termination of any predetermined number of cutter-head strokes. Crossed-axes setting of the cutter-spindle to any angle with the work-gear axis up to 40 degrees is accomplished with a vernier scale and indicator. A single knob controls the increment of in feed at each end of the cutter-head stroke for internal or external gears.

Visual reference to the point at which the automatic feed terminates is shown on a dial synchronized with the feed-screw that actuates the horizontal slide. Controls are also provided for changing the direction of feed in relation to table rotation and for disengaging the power feed to permit manual adjustment of the horizontal slide. Push-button control is available for jogging the table to facilitate clamping work in the fixture, and there is a dial for determining the cutting rate in surface feet per minute. A graduated dial control facilitates setting the machine to compensate for distortion in the gear teeth caused by the heat-treating operation.

The power hoist shown in the illustration, which is available if desired, is designed to facilitate loading heavy or bulky gears. This equipment consists of a free swinging jib crane mounted on the machine base and a 500-pound capacity electric hoist with sensitive control. A self-contained hydraulic work-ejector controlled by a foot-pedal lifts the work out of the quick-clamping fixture and also serves as a loading platform. The electrical control panel, coolant tank and pump, chip container, and driving motor, which has a separate ventilated compartment, are all enclosed in the machine base. 51

LeMaire Universal-Joint Spider Milling and Facing Machine

A machine designed to automatically hollow-mill and face the four trunnions of universal-joint spiders simultaneously has been brought out by the LeMaire Tool & Mfg. Co., 2671 S. Telegraph Road, Dearborn, Mich. This machine, as shown in Fig. 1, consists of four standard end bases, each supporting a LeMaire twin ram hydraulic unit, and a special center base to which the four end bases are bolted.

The spider to be machined is placed on the center fixture. Pressing a control button causes the work to be automatically locked and held securely by air-operated clamps while four spindles at stations spaced 90 degrees apart advance rapidly, slow down to the hollow-milling speed, dwell, and then withdraw rapidly under full automatic control. Thus the four trunnions of the spider are machined to the required diameter and their four shoulders are faced in one automatic operation.

Stepless adjustment of the spindle speeds to suit the work diameter is available. Production is approximately 150 pieces an hour on trunnions 5/8 inch in diameter by 5/8 inch in length. Although this machine is equipped for hollow-milling operations, it can also be arranged for boring, drilling, and reaming operations. 52

McGill Toggle Switch

A small, thin toggle switch has been developed by the McGill Mfg. Co., Inc., Valparaiso, Ind., which will find application in small machine tools and appliances. The construction is dust- and vibration-proof. Since the switch is only 1/2 inch square by 1 inch long, it will fit shallow openings. 53

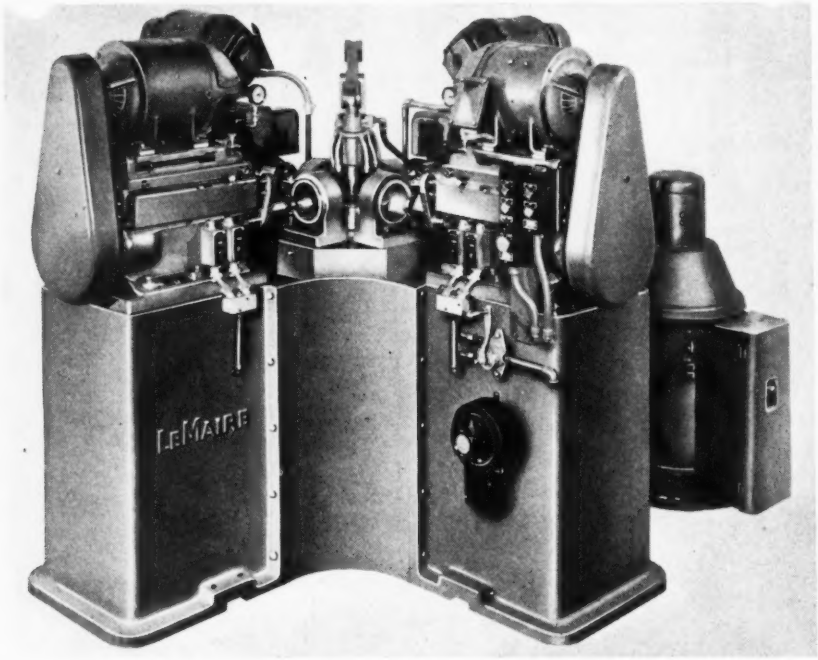


Fig. 1. Le Maire Machine Designed to Finish Four Universal-joint Spider Trunnions Simultaneously

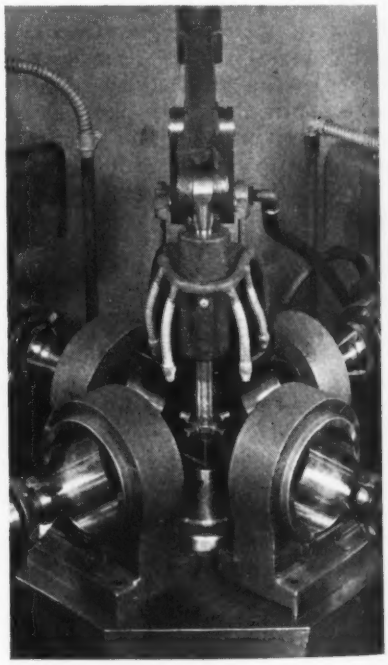


Fig. 2. Close-up View of Work and Cutters of Le Maire Machine

To obtain additional information on equipment described on this page, see lower part of page 214.

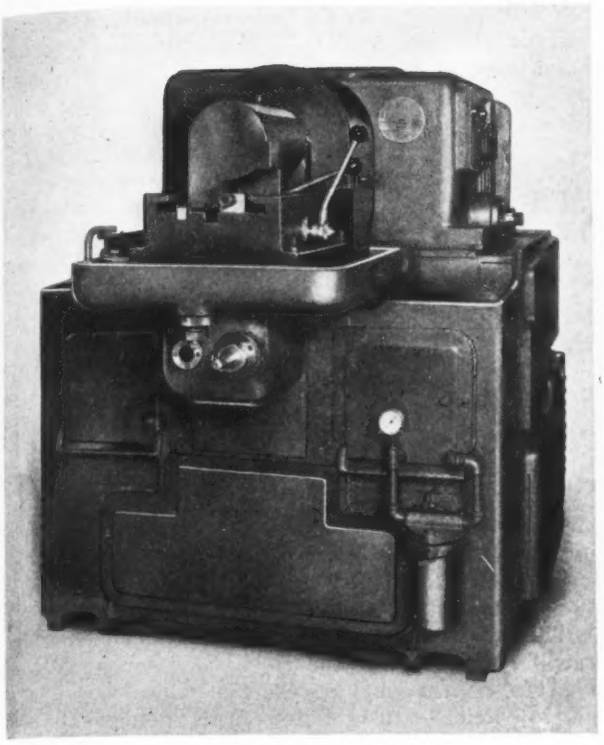


Fig. 1. Fellows Gear-shaving Machine Designed to Shave Internal Gears with either Spur or Helical Teeth

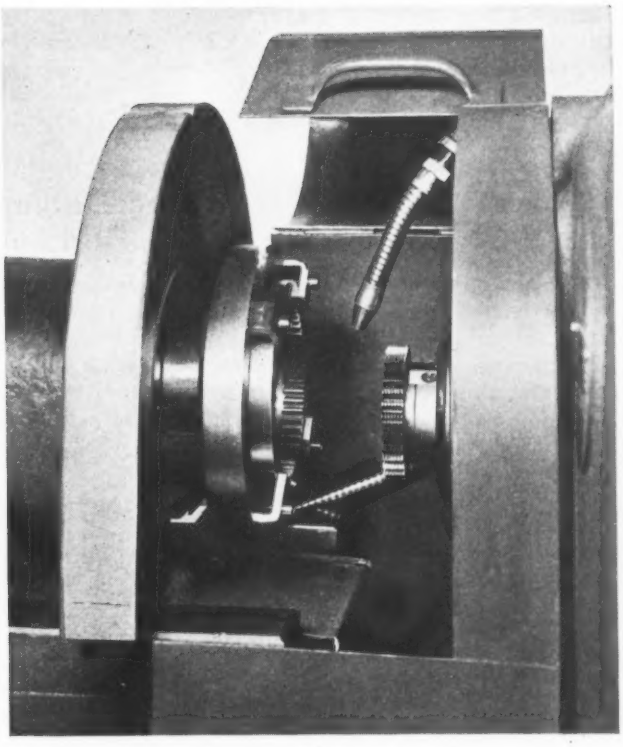


Fig. 2. Close-up View of Fixture, Tool, and Work of Fellows Gear-shaving Machine Shown in Fig. 1

Fellows Internal Gear-Shaving Machine

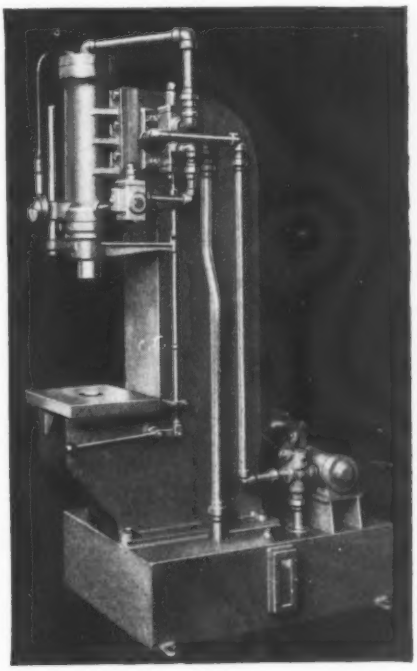
The Fellows Gear Shaper Co., Springfield, Vt., has recently placed on the market a new machine for shaving internal spur and helical gears. This machine operates on what is known as the "parallel axes" principle in that the shaving tool and work are held with their axes parallel to each other when the tool is operating. A rotary type of shaving tool is employed. This is held on a rigidly mounted spindle, which is reciprocated at comparatively high speed. The work is held in a fixture mounted on an adjustable knee, which is operated by a depth feed cam to bring the work into contact with the tool under pressure.

The desired shaving action is obtained by proportioning the rotating and reciprocating movements of the tool so that the tool "skids" on the tooth profile of the work, thus effecting the desired finish. In operation, the tool is rotated in one direction to finish one side of the teeth, and then reversed to finish the other side of the teeth. This reversal of direction of rotation, as well as control of the number of strokes for each direction, is accomplished automatically.

The shaving tool spindle is reciprocated by a crank mechanism, and is controlled by a guide, a straight guide being used when shaving spur gears and a helical guide for helical gears. The tool drives the work, and is reciprocated a comparatively short distance—approximately 1/8 inch. The machine is provided with complete electrical control, and is operated by push-buttons. The maximum capacities are as follows: Diametral pitch, 6 inches; face width up to 10 pitch, 1 1/2 inches; and face width from 12 to 16 pitch, 1 inch. The diameter capacity is governed by the design of the work, fixture, and size of shaving tool used. 54

Beatty Gap Type Hydraulic Press

A 15-ton gap type hydraulic press, originally designed for the high-speed broaching of small bronze bushings, but generally applicable in machine shops, railway car shops, and repair shops for straightening operations and for the removal and insertion of bronze bushings and bearings, has been brought out by the Beatty Machine & Mfg. Co., 150th and Oak St., Hammond, Ind. This press has a maximum capacity of 15 tons; stroke, 15 inches; advance and pressing speed, 208 inches per min-



Beatty Hydraulic Broaching and Straightening Press

To obtain additional information on equipment described on this page, see lower part of page 214.

ute; return speed, 432 inches per minute; maximum opening, 20 inches; minimum die space, 5 inches; gap, 9 1/2 inches; table size, 20 by 16 inches. The table is provided with a clearance hole 4 inches in diameter to permit the removal of press parts and tools. This type press is also made in sizes up to 350 tons. 55

Baker Vertical Hydraulic-Feed Drilling and Boring Machine with Auxiliary Horizontal Unit

A heavy-duty 60-HO vertical hydraulic-feed machine with an auxiliary horizontal hydraulic-feed unit arranged as shown in the accompanying illustration has been brought out by Baker Brothers, Inc., P. O. Box 101, Station F, Toledo 10, Ohio. This machine is especially equipped for handling core-drilling, boring, and counterboring operations on right- and left-hand track links for tractors. Two track links—one right-hand and one left-hand—are produced at each cycle of the machine.

The four-station power indexing table permits the loading and unloading of two parts at the chucking position while the machine is cutting. The vertical, extra heavy duty, hydraulic-feed unit performs the various operations required in the two large bores in the links, and the multiple-head horizontal unit drills the two bolt-holes in the side of the links. This fully automatic operation reduces the operator's duties to simply loading and unloading.

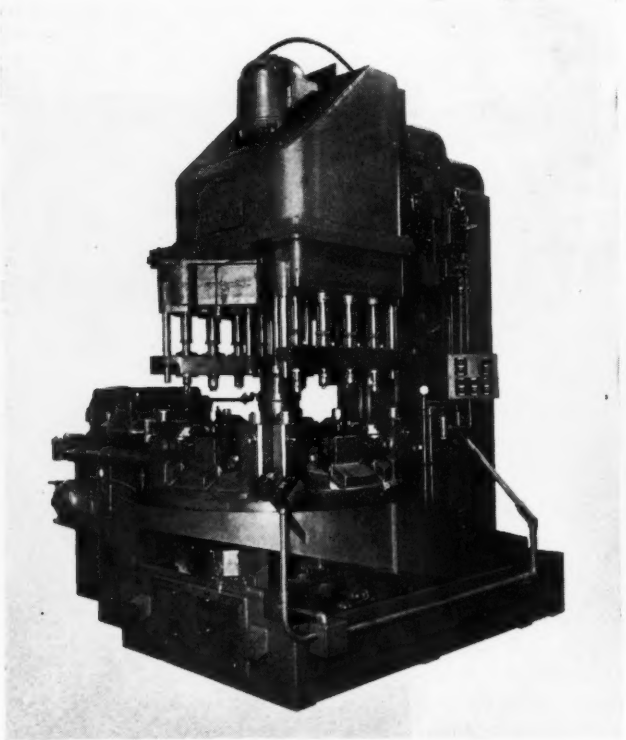
The vertical feed unit is furnished with a heavy-duty, twelve-spindle head mounted on a large saddle. The machine has a center-mounted cylinder which applies feeding power at the center point equally distant from all spindles. The feeding cylinder is mounted in a fixed position on the center of the indexing table, which carries the work-holding fixtures that rotate around the cylinder. Support for the tools is provided by a bushing plate on the head of the machine, which operates in conjunction with bushings in the fixtures. Control is by push-button stations. 56

Portable Weld-Testing Machine

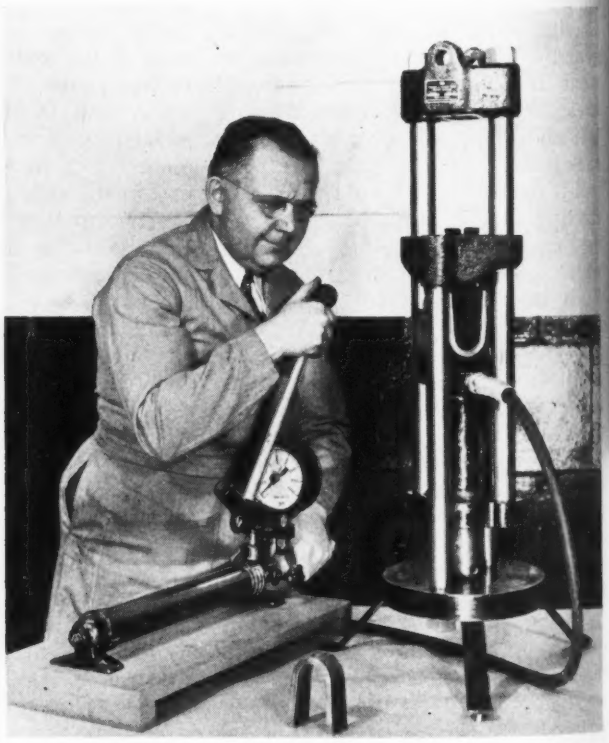
An improved portable weld-testing machine has just been introduced to the trade by the Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y. This machine is said to be the only available portable type unit that performs the three tests applied to welds—namely the reduced section transverse tension test; the guided bend test (a complete 180-degree face or root bend); and the longitudinal all-weld metal tension test.

Two outstanding advantages of this machine are stressed by the manufacturer—first, its ability to provide accurate data on tensile strength and ductility of weld specimens, as determined by the three tests; and second, its relatively light weight, which enables users to perform weld tests right on the job. The latter feature makes the machine particularly useful for firms doing extensive field work, such as pipe-line installation, construction, and similar jobs performed in remote locations.

The machine operates on the principle of the hydraulic jack. A hand-operated pump transmits pressure through a hose to the plunger. While the maximum direct load is 40,000 pounds, the use

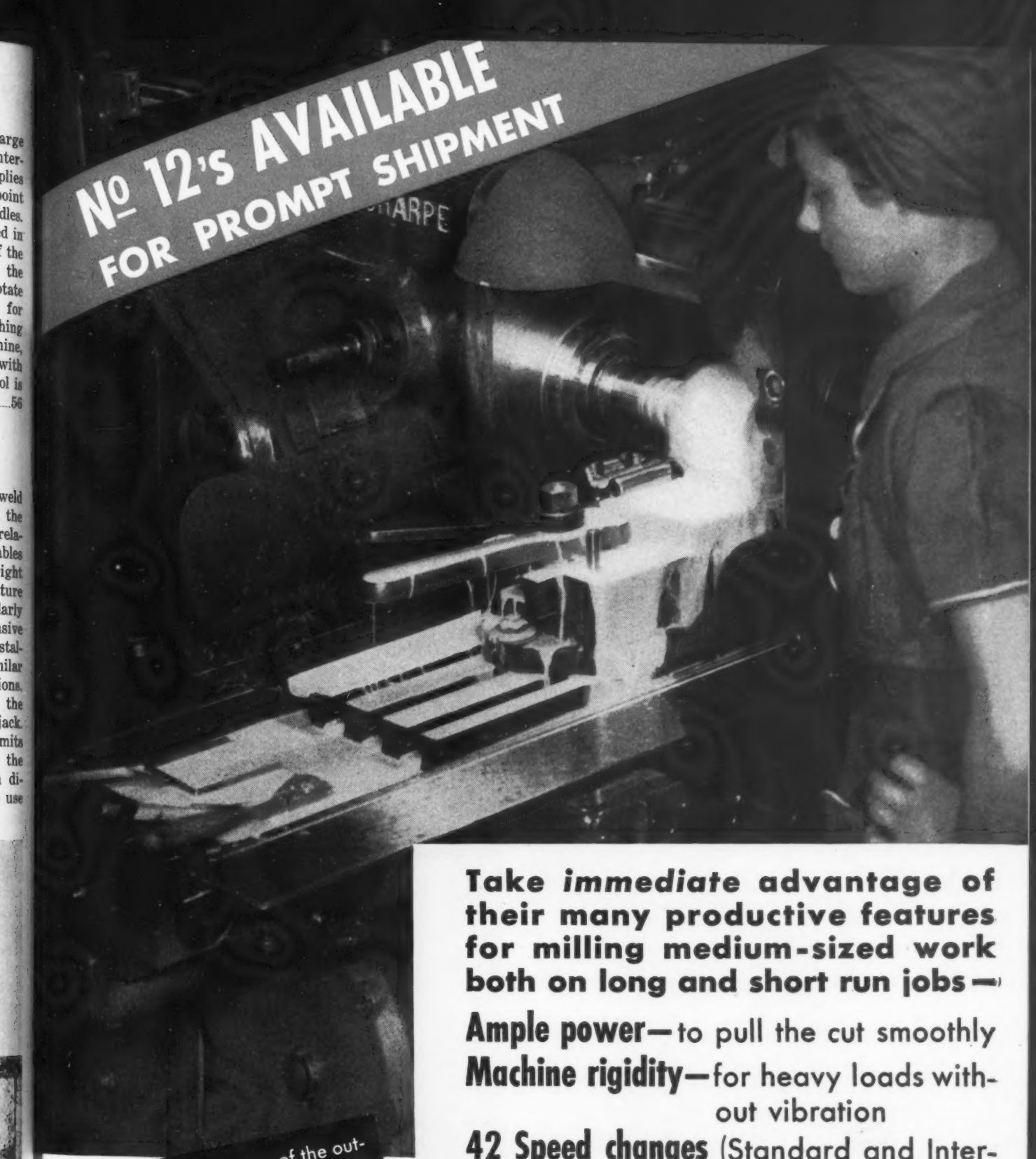


Baker Hydraulic-feed Machine Equipped for Drilling and Boring Tractor Links



Portable Weld-testing Machine Placed on the Market by the Air Reduction Sales Co.

To obtain additional information on equipment described on this page, see lower part of page 214.



Climb Milling is one of the outstanding features of the **No. 12 Plain Milling Machine** on present day requirements.

B&S BROWN & SHARPE MFG. CO.
PROVIDENCE 1, R. I., U.S.A.

Take *immediate* advantage of their many productive features for milling medium-sized work both on long and short run jobs—

Ample power—to pull the cut smoothly

Machine rigidity—for heavy loads without vibration

42 Speed changes (Standard and Intermediate) 25 to 1050 R.P.M.—permitting best selection for cutter and work

28 Feed changes—½" to 35" per minute—permitting most advantageous feed selection. Many may be used in **dual-combination** to reduce cutting time

BROWN & SHARPE

of reduced section specimens permits tests on metals of 150,000 pounds per square inch or higher tensile strength. Jaws for making the transverse tension test, and a plunger and die for the guided bend test are supplied with the machine. Jaws for the longitudinal all-weld metal tension test can also be furnished. 57

Hanchett Five-Spindle Surface Grinder

Increased grinding capacity and the adaptability for a wider range of work are afforded by a new five-spindle surface grinder now being introduced on the market by the Hanchett Mfg. Co., Big Rapids, Mich. This machine, designated the No. 100, is designed especially for high-speed, high-capacity production, and is larger than the No. 72 grinder previously brought out, although the operating principle is the same. The No. 100 grinder has a T-slotted work table, 100 inches in diameter by 20 inches in width, and is driven through a P.I.V. variable-speed unit by a 5-H.P. 1200-R.P.M. motor.

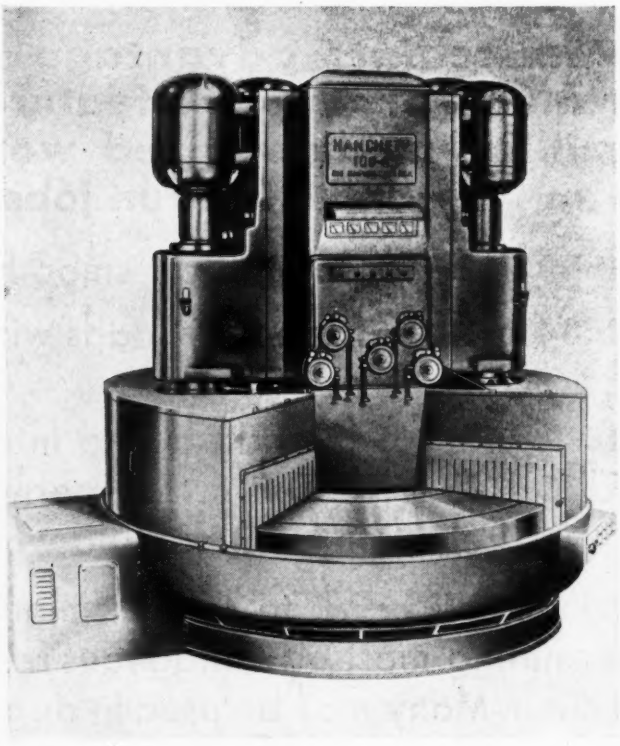
Each of the five grinding wheel heads of this surface grinder has a 40-H.P. 900-R.P.M. motor, making a total of 200 H.P. for operating the grinding wheels. Each grinding wheel head is fitted with a sizing device which automatically compensates for wheel wear, operating in increments of 0.0002 inch. The first three grinding wheels, which serve as the stock-removing wheels, are usually of the coarse-grain type, the fourth wheel is of medium fine grain, while the fifth or finishing wheel has a rather fine grain. Wheels of the correct grain number can be selected to suit the work. In a recent test on cast-iron cylinder blocks, this new machine removed stock at the rate of 8 cubic inches per minute, leaving an accurate straight and flat surface with a fine finish.

The grinder is equipped with a wheel-dresser for each wheel-head, and each head is provided with a built-in ammeter, so that the action of the grinding wheels can be easily observed. Regular equipment includes floodlights, guards and coolant system. The machine weighs about 55,000 pounds. 58

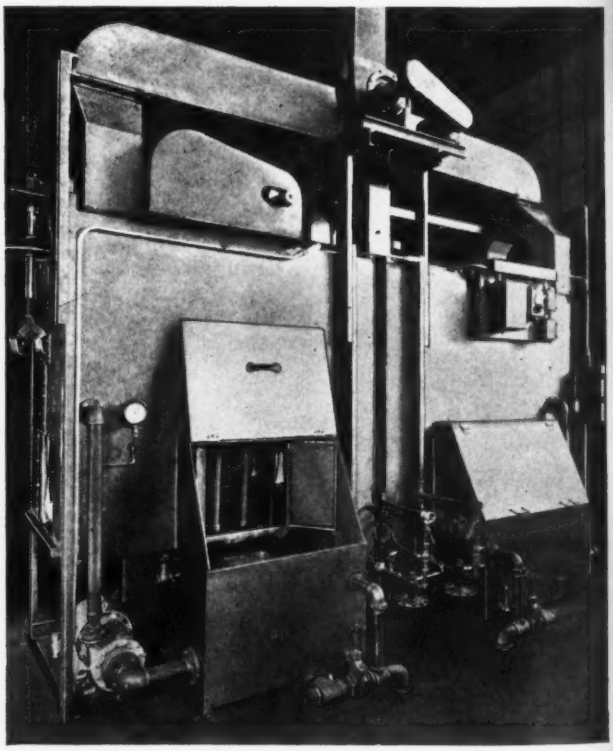
"Monorail-Spray" Metal Washer

An improved metal washer known as the "Monorail-Spray" has been developed by the Metal Washing Machine Division, American Foundry Equipment Co., 555 Byrkit St., Mishawaka, Ind., to handle metal parts that must be rotated while they are passing through the cleaning chamber. Typical work handled includes intricate circular parts or pieces with many ports, crevices, or openings. A monorail conveyor is provided with this washer to carry the work through the path of properly positioned power sprays. The work is suspended from hooks and rotated while passing through the cleaning stages.

The high-pressure pumps and controls can be easily serviced. Large doors are provided to permit removal of the spray system for cleaning. Although the standard model Monorail-Spray washer is designed primarily for washing and rinsing operations, it is so constructed that additional units or sections for such operations as drying and rustproofing can easily be added to the machine to suit variations in production set-ups.



Five-spindle Surface Grinder Built by the Hanchett Mfg. Co.



"Monorail-Spray" Metal-washing Machine with Conveyor that Rotates Work

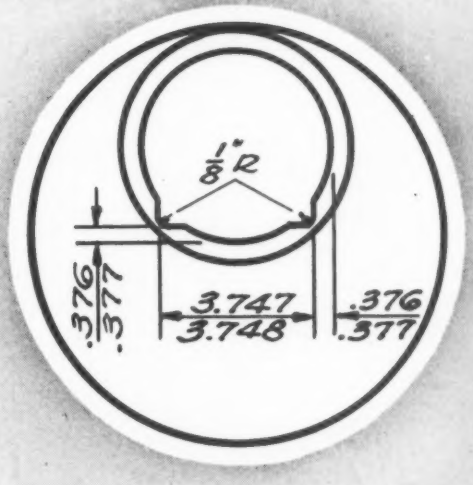
To obtain additional information on equipment described on this page, see lower part of page 214.

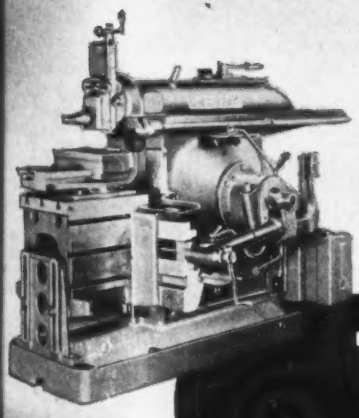
INTERNAL SHAPING...

In the field of internal shaping alone, Cincinnati Shapers are used on a long list of "hard to get at jobs"—from cutting internal key ways to cutting symmetrical and non-symmetrical holes.

We show a Cincinnati Shaper shaping internal key ways in a blind hole—a "hard to get at job." Remember, a Cincinnati Shaper, the tool of many uses, will always be busy in your shop.

Write for Catalog N-2, describing these powerful accurate Shapers.





THE CINCINNATI SHAPER CO.

CINCINNATI OHIO U.S.A.

SHAPERS · SHEARS · BRAKES

The unit can be equipped for heating with steam, gas coils, or electric immersion heaters under thermostatic control. Steam and vapors are carried away by ventilation ducts at the top of the unit. 59

Colonial "Junior" Hydraulic Presses

A line of general-purpose "Junior" hydraulic presses of streamline design, in both bench and base types, has been announced to the trade by the Colonial Broach Co., Detroit 13, Mich. This new line includes presses of 1-, 2-, and 4-ton capacities. The design and operating characteristics provide a high degree of flexibility for general shop use or for conversion from one form of operation to another. These presses can be used for assembly work and for push- or pull-broaching. They can be converted from bench to pedestal or pedestal to bench types as required, since the bench type press is simply bolted to a reinforced base to form the pedestal machine.

The platens are counterbored concentric with the ram to facilitate location of fixtures in line with the ram movement. The base below the platen is slotted and relieved to adapt the press for assembly work. Direct-drive electric motors, designed for either 50- or 60-cycle operation, are vertically mounted in the column to furnish power for the hydraulic operating mechanism. The ram stroke is easily altered by changing the positions of the stop-collars. The machines can be arranged either to stop the ram at both the top and bottom of each stroke, or to stop it at the top only, with automatic return when the bottom of the stroke is reached.

For broaching, the pedestal type models are available with a large coolant reservoir, chip strainers, and a centrifugal type coolant pump with individual motor drive. When intended for pull-broaching operations, the platen is bored and provided with long guide bushings for the hardened and ground yoke guide rods which extend into the base of the machine. The yoke has a broach-puller at the lower end, and provides for a longer maximum stroke for pull-broaching than that available in previous models.

The smallest machine has a normal ram speed of 30 feet per minute, and the largest 15 feet per minute. 60

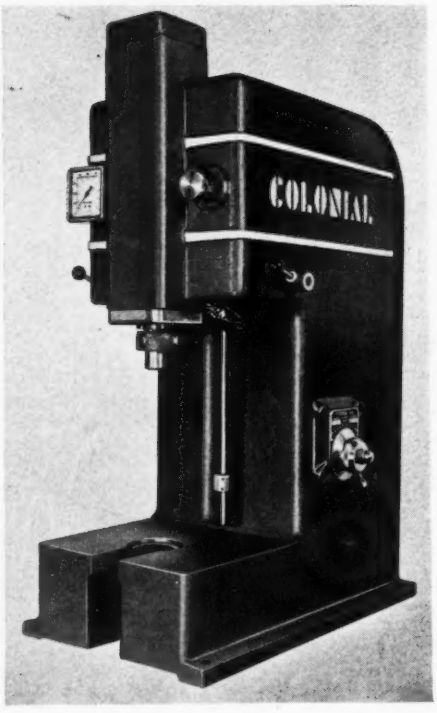


Fig. 1. Colonial "Junior" 2-ton Hydraulic Bench Press Equipped for Assembly Work

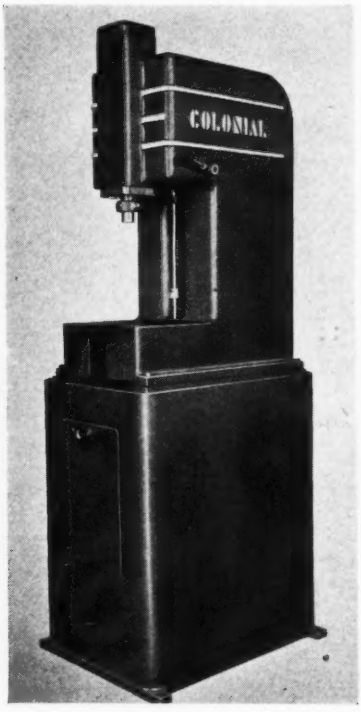
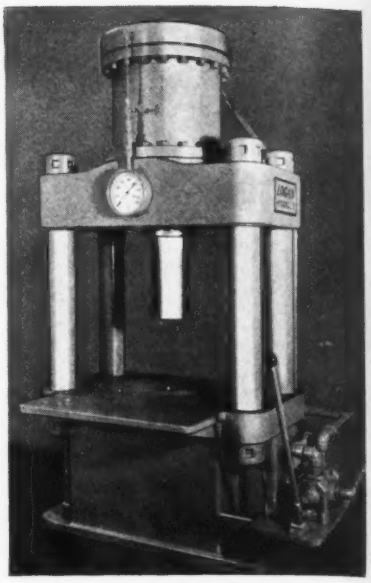


Fig. 2. Colonial "Junior" Hydraulic Pedestal Press Equipped for Broaching



Logansport Four-post Press for Heavy Forcing and Forming

Special Logansport Press for Heavy Forcing and Forming Operations

A special four-post tie-rod type hydraulic press designed for heavy forcing and forming operations has just been built by the Logansport Machine Co., Inc., 910 Payson Road, Logansport, Ind. This press has a maximum ram opening of 30 inches and a 15-inch stroke.

A dual-volume hydraulic pump provides low-pressure operation during the non-forcing portion of the operating cycle and high-pressure operation during the actual forcing portion of the cycle. The change-over from one pressure to the other is accomplished automatically, as demanded by the resistance developed to oppose the ram movement. The proportional pressure valve is designed to permit the gradual application of pressing force from zero to the full capacity of the press. A special platen extension is provided to facilitate loading and unloading. 61

Sheffield "Precisionplate" Gages

Thread gages finished by the "Precisionplate" process are now being made by the Sheffield Corporation, Dayton 1, Ohio. This process uniformly bonds chromium to the full thread form on the gage. The chromium is so bonded to the

To obtain additional information on equipment described on this page, see lower part of page 214.

Super Service

DRILLING AT *"Lockheed's"*

THE JOB: Drilling and reaming slip fit holes in aircraft motor support brackets.

THE PLANT: One of the shops of the Lockheed Aircraft Corporation.

THE MACHINE: One of a battery of Super Service Box Column Upright Drilling Machines.

Features of the Cincinnati Bickford Super Service Uprights include PRODUCTIVITY—CAPACITY—ADAPTABILITY—RELIABILITY—ACCURACY—CONVENIENCE—ECONOMY, all of which combine to make these machines absolutely dependable for precision and heavy duty aircraft production. Available in either round-column or box-column models—21″, 24″ and 28″ capacity. Bulletin U-25 gives complete details and specifications; write for copy today.

ARMY (E) NAVY

THE CINCINNATI BICKFORD TOOL CO. OAKLEY, CINCINNATI, OHIO, U. S. A.

steel that it resists chipping off to a remarkable degree. It is stated that both laboratory and field tests indicate that the life of thread gages so made averages from four to six times the life of conventional steel gages. It is further stated that "Precisionplate" increases the resistance to corrosion caused by handling or by the atmosphere, as well as scoring, marring, and other damage due to rough handling. ..62

"Check-Matic" Designed for Automatically Checking Dimensions of Parts

An ingenious machine called the "Check-Matic," designed for the automatic inspection of parts up to 1 1/2 inches in diameter by 2 inches in height, checking with "Go" and "No Go" gages such dimensions as outside and inside diameter, depth of counterbore, wall thickness, and depth of holes to limits of 0.001 inch, has been placed on the market by Inter-Lakes Engineering Co., 502 Transportation Bldg., Detroit, 26, Mich.

The parts to be inspected are simply placed in holes in the revolving dial of the machine, which carries them successively to the various gages. If any part, as it progresses from one gage to another, does not pass any particular inspection test, it is automatically ejected through a tube, which deposits it in a receptacle. As each gage has its own individual rejection tube, the rejected parts are segregated according to the particular inspection they failed to pass.

The standard model has an 18-hole dial, and is designed to check as many as thirteen dimensions. The gage elements and dial bushings can be quickly changed for the inspection of parts of different shapes and dimensions. It is claimed that the "Check-Matic," by eliminating the human element, provides more accurate inspection than has previously been possible by conventional methods. It also reduces inspection time to a fraction of that formerly required. For example, a machine like the one illustrated is equipped to perform seven dimensional inspections, including a concentricity check, at the rate of fifty-five pieces per minute. A plastic hood covers the gages and delicate operating parts of the machine, protecting them from dust and moisture not only when the machine is idle, but also when it is in operation. 63

Carriage-Mounted Drills for Drilling Airplane Spars

The Farnham Mfg. Co., Buffalo, N. Y., is building a new line of high-speed carriage type drills for the production drilling of aluminum-alloy spars, wing panels, and other long assemblies. The units are furnished complete, ready for installation on rails which are fastened to an assembly fixture. Only the addition of the rails is necessary to make an existing assembly fixture suitable for the machine drilling of holes up to 3/8 inch in diameter.

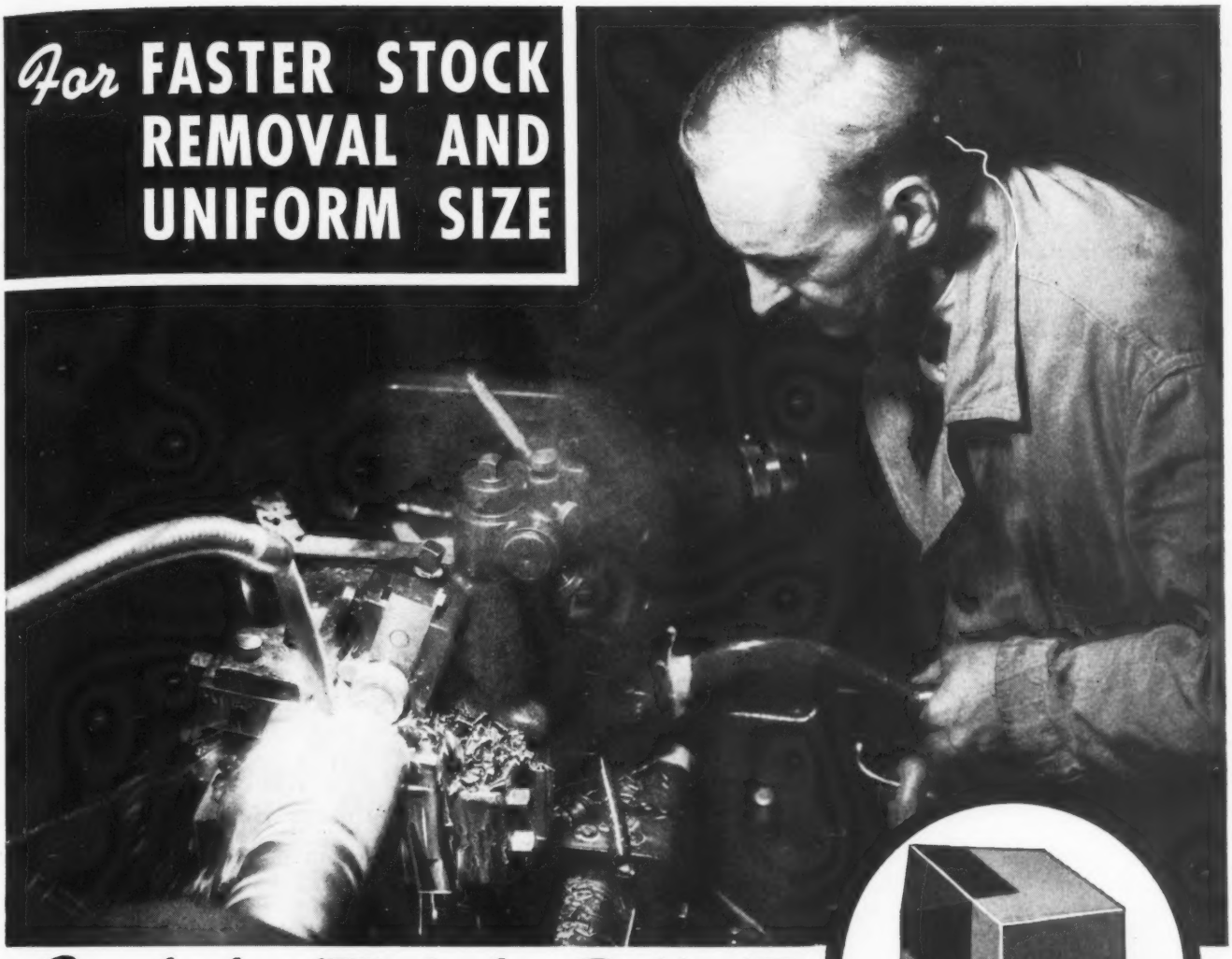
A variety of carriage mountings is available in both horizontal and vertical types. For work with curved surfaces, such as wing panels, a carriage unit is available which is automatically controlled by a cam that keeps the drill perpendicular to the surface to be drilled as the carriage travels along a straight track. The feeding of the drill to the required depth and its return movement are entirely automatic. After the drill unit is located manually by means of a positioning hole in the jig, a control button is pressed, which causes the remaining cycle of operations to proceed automatically as follows: First, pressure is applied to the

"Check-Matic" Brought out by Inter-Lakes Engineering Co.

Farnham Carriage-mounted Drill for Drilling Aluminum-alloy Spars

To obtain additional information on equipment described on this page, see lower part of page 214.

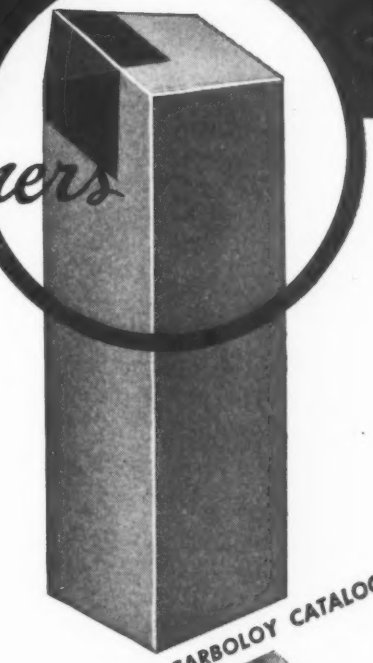
For FASTER STOCK REMOVAL AND UNIFORM SIZE



Carboloy Tools for Roller Turners

For faster stock removal, uniform size and smoother finish on your machining of bar stock, you'll find Carboloy Roller Turner Tools of unusual value. They hold size for extremely long periods of use, eliminate frequent downtime for tool changes and operate at speeds far beyond the range of ordinary tools. Large Carboloy Tips insure extra-long tool life, maximum tool economy.

Carried in stock ready for prompt deliveries. Standard styles for Gisholt, and Warner & Swasey Turret Lathes. For top production, and maximum economy, put Carboloy Roller Turner Tools on your jobs. Write for catalog GT-175.



SEND FOR NEW CARBOLOY CATALOG

CARBOLOY COMPANY, INC.
Sole makers of the Carboloy brand of cemented carbides
11147 EAST 8 MILE ROAD, DETROIT 32, MICHIGAN
Birmingham • Chicago • Cleveland • Los Angeles • Newark • Philadelphia • Pittsburgh • Seattle • Thomaston, Conn.

CARBOLOY TRADEMARK

For Cutting CAST IRON and Non-Ferrous Metals

For Cutting STEEL

TUNGSTEN CARBIDES ★★★ TUNGSTEN CARBIDES WITH TANTALUM AND/OR TITANIUM CARBIDES

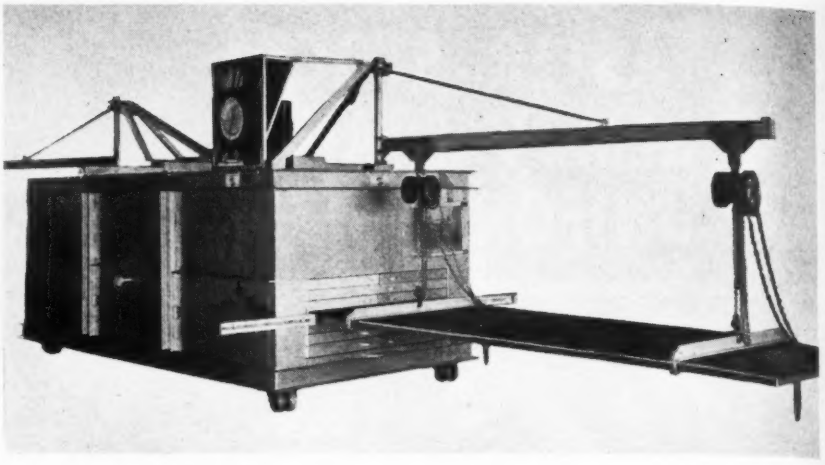
drill bushing to hold the unit firmly in place; second, the drill is advanced at a fast feeding rate; third, the feed is automatically slowed down for drilling when the drill reaches the work (the drilling feed is adjustable); and fourth, when the predetermined depth stop is reached, the drill is returned to the starting position. The drill spindle is belt-driven by a standard-cycle 1/2-H.P. motor at speeds up to 10,000 R.P.M. 64

Knapp-Lee Magnesium Preheating Furnace

A new furnace designed to preheat magnesium sheets and plates to a temperature of 600 degrees F. for hot-forming has been brought out by the James H. Knapp Co., Inc., 4920 Loma Vista Ave., Los Angeles 11, Calif. This self-contained furnace is mounted on four ball-bearing double casters to permit moving it to the hot-forming presses. There are seven double doors at each end of the furnace which facilitate loading and unloading the magnesium sheets. Seven magnesium sheets, each 4 feet wide, 12 feet long, and 1/4 inch thick, can be accommodated.

The furnace is electrically heated and is equipped with three blowers mounted on one shaft. Heating elements in the chamber in front of the blowers extend the full length of the furnace. A Leeds & Northrup potentiometer recorder with special contacts provides for reduced heat control during the "soaking" period or for low-temperature operation.

Jib booms at the furnace ends, equipped with chain hoists, handle the hot tray loads. To facilitate moving the furnace, the booms are folded back over the furnace, so that the over-all dimensions are approximately 9 feet high, 9 feet wide, and 17 feet long. With the booms extended, the over-all length of the equipment is 38 feet. 65



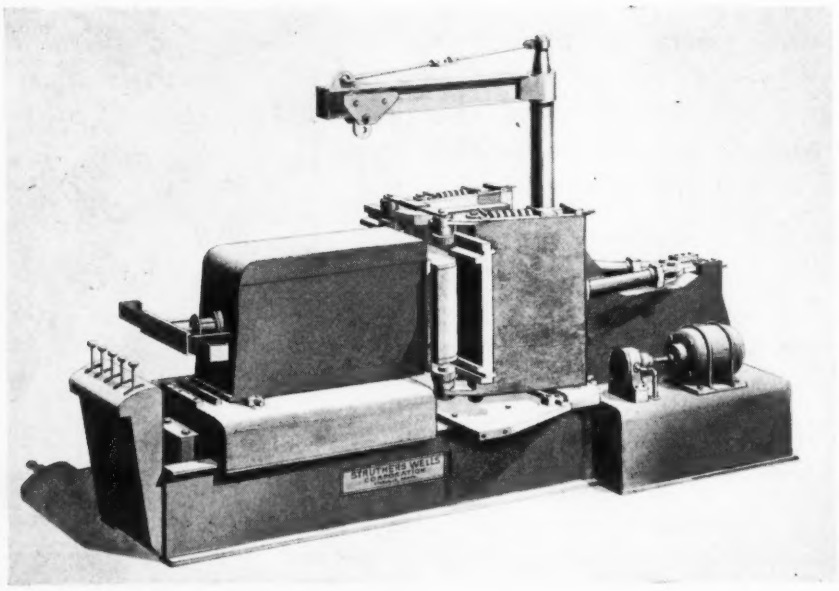
Knapp-Lee Furnace Developed for Preheating Magnesium Sheets Preparatory to Hot-forming

Struthers Wells Tangent Bender

Tangent bends in many convenient forms can be made cold in sheet metal of the lighter gages in one operation on the improved tangent bender recently brought out by the Struthers Wells Corporation, Titusville, Pa. The metal formed by this bender is smoothly upset, so that no further finishing is required. This improved bender is designed to effect greater economy in the production of many types of new streamline equipment, such as refrigerator cases, kitchen cabinets, stoves, metal furniture, airplane and automobile parts, etc.

The bender is designed primarily for improved edge beveling operations, but it can also be used to advantage as a horizontal press for blanking, piercing, forming, embossing, and many other continuous operations. Special features include a self-contained hydraulic unit; independently controlled forming wings; large die back support; quick-change radius gears; oversize swivel post in the ram; extra long ram carriage; oil reservoir; and crane for handling the dies.

The main ram pressure is 50 tons, and the main ram stroke 10 inches. The radius bending wings have a swing of 109 degrees. The maximum center distance between double bends is 34 inches, and the minimum distance 17 1/2 inches. The available die space is 19 by 24 inches, and the die opening 21 1/2 inches. Straight angle bends can be made in lengths up to 52 inches. The machine is operated by a 5-H.P. motor, and requires a floor space of 52 by 177 inches. 66



Struthers Wells Tangent Bender for Cold-forming Light-gage Sheet Metal

To obtain additional information on equipment described on this page, see lower part of page 214.

From 1919 to 1944 – a QUARTER CENTURY of ENGINEERING and PRODUCTION ACHIEVEMENT

Solving difficult production problems for American industry has been the business of Ex-Cell-O since its inception twenty-five years ago. Often this has entailed the development of special purpose machines for single and multiple operations . . . to do work faster, more economically, and with a much higher degree of accuracy. Where the quantities have justified it, Ex-Cell-O has not only designed and built special machines to produce parts of improved quality but has undertaken actual production and assembly of these parts in its own plant, using to practical advantage Ex-Cell-O's complete heat treat equipment and widely-experienced production staff.

The days ahead . . . both war and postwar . . . are likely to offer a multitude of opportunities for the kind of engineering and production assistance that Ex-Cell-O can give so well. Consequently, the suggestion is made that, insofar as is practicable, *your* planning be started early. Ex-Cell-O's extensive facilities are at your disposal. Write to Ex-Cell-O in Detroit today.

Ex-Cell-O "Firsts"

EX-CELL-O was the first company in the United States to design and manufacture and introduce for successful commercial use...

- ...a precision ball bearing internal grinding spindle
- ...a horizontal-type precision boring machine
- ...a precision thread grinding machine
- ...a precision cylinder boring machine
- ...a 1½ horsepower compact hydraulic power unit
- ...a Diesel fuel injection pump and a universal-type Diesel engine nozzle
- ...a machine to form and fill automatically square paper milk bottles in the dairy

EX-CELL-O was also the first American company to undertake the mass production of hardened and ground precision parts for aircraft engines.

EX-CELL-O CORPORATION • DETROIT

An Ex-Cell-O 25th Anniversary Book, illustrated above, has just been printed. If you would like a copy just write to Ex-Cell-O Corporation, 1200 Oakman Boulevard, Detroit 6, Michigan.

SPECIAL MULTIPLE WAY-TYPE PRECISION BORING MACHINES • SPECIAL MULTIPLE PRECISION DRILLING MACHINES • PRECISION THREAD GRINDING, BORING AND LAPPING MACHINES • BROACHES AND BROACH GRINDING MACHINES • HYDRAULIC POWER UNITS GRINDING SPINDLES • DRILL JIG BUSHINGS • CONTINENTAL CUTTING TOOLS • TOOL GRINDERS • DIESEL FUEL INJECTION EQUIPMENT • R. R. PINS AND BUSHINGS • PURE-PAK MILK CONTAINER MACHINES • PRECISION AIRCRAFT AND MISCELLANEOUS PARTS

Lester-Phoenix Injection Molding Machine

A machine designed by the Lester Engineering Co. for injection molding of thermoplastic material; injection molding, by the jet process, of thermosetting material and rubber compounds; and injection molding of electronically heated preforms in plastics or rubber has been brought out by the Lester-Phoenix, Inc., 2711 Church Ave., Cleveland 13, Ohio. This new Model 3V-12 press is built in a vertical design with horizontal die platens for moldings having inserts that must remain fixed in their proper positions. The injection molding of thermoplastic materials is accomplished in the same manner as in the standard Lester horizontal injection type machine with a vertical cylinder, using a hollow plunger, but without the usual right-angle delivery, which is unnecessary in the new machine.

The injection molding of thermosetting material and rubber can be accomplished by either jet injection of granular material or plunger injection of electronically heated preforms. Choice between the two depends upon the weight and size of the parts. Jet molding usually is employed for parts weighing up to 12 ounces, although heavier moldings can be produced. It eliminates the production and handling of pre-forms, since granular material is used.

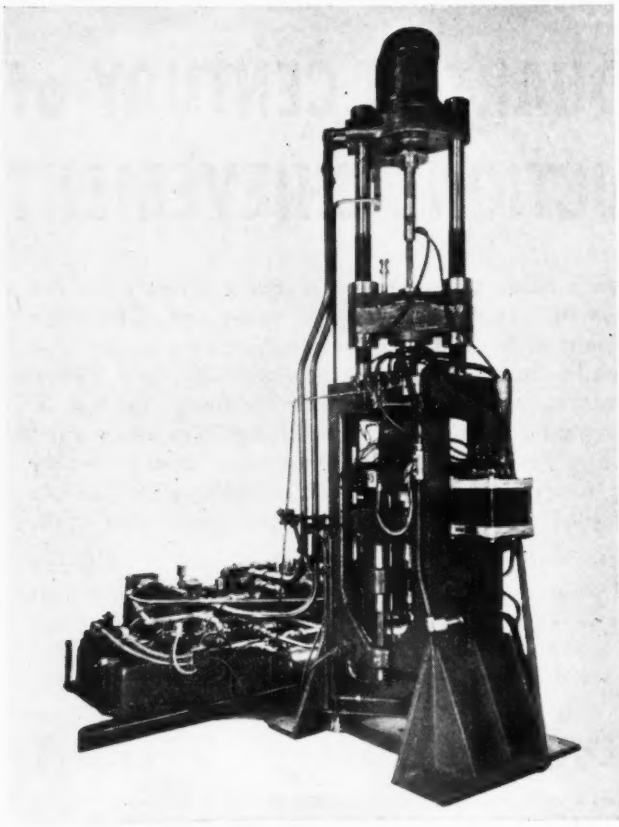
In the injection molding of electronically heated pre-forms, the plastic or rubber pre-forms are placed between the electrostatic plates of a high-frequency generator. High-cycle alternating current is passed between the plates, heating the pre-forms uniformly. When the pre-forms reach a temperature just short of curing, they are placed in a vertical injection cylinder and then forced by the hydraulically actuated plunger through runners in the die cavities. Heat is applied to and within the die, accomplishing the curing in a fraction of the time required by surface contact heating.

In both jet molding and injection molding of electronically heated pre-forms, the cycle time is reduced to 1/2 to 1/50 of that required by methods previously employed. The machine shown is self-contained, having a 30-H.P. motor, hydraulic equipment, and electric timing controls. ----67

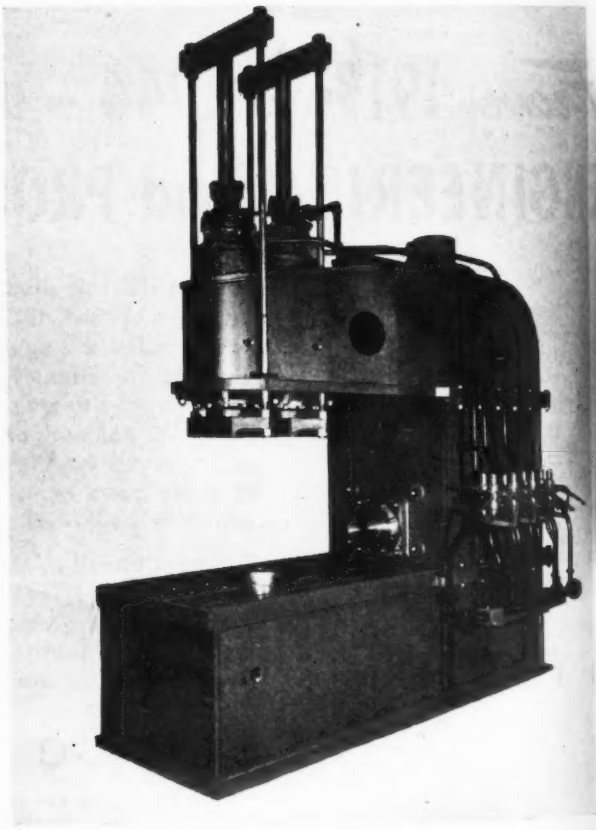
Wood Sectional Flanging Press

A hydraulic sectional flanging press designed for a working capacity pressure of 1500 pounds per square inch has recently been completed by the R. D. Wood Co., Philadelphia 5, Pa. Enclosed within the three-piece heavy welded steel-plate frame of this press are two 10-inch tension columns which carry the full stress of the working load. There are two 16 3/4-inch diameter vertical main rams, a 14-inch stripper ram, and a 15 1/2-inch double-acting horizontal ram. The travel of the main rams is 30 inches, and each has a capacity of 150 tons.

All control valves are arranged in pulpit form, which permits operating each of the two vertical main rams separately or both rams together to obtain a total capacity of 300 tons. The stroke of both the



Injection Molding Machine Made by Lester-Phoenix, Inc.



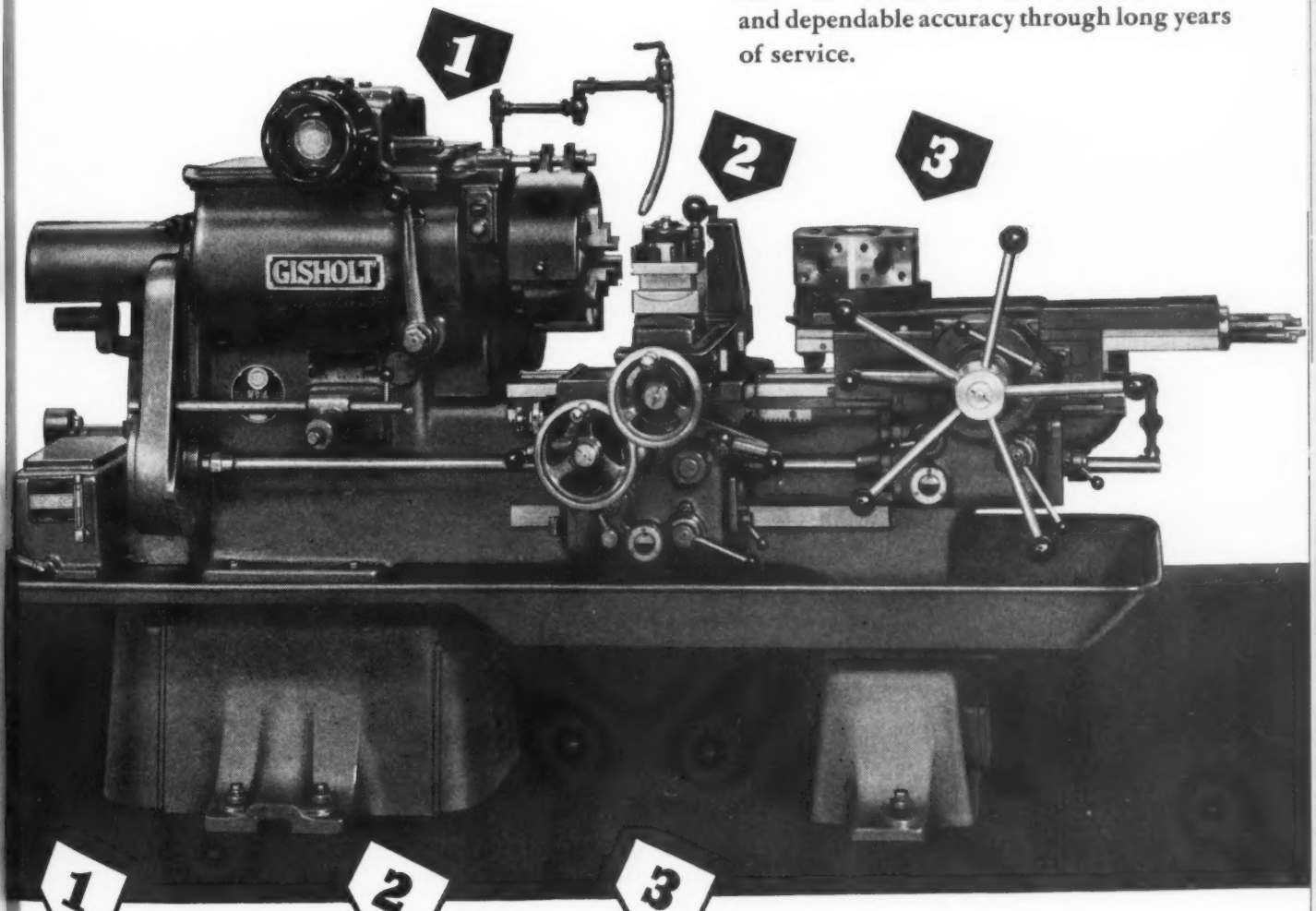
Hydraulic Flanging Press Brought out by the R. D. Wood Co.

To obtain additional information on equipment described on this page, see lower part of page 214

Strength . . .

WHERE IT'S NEEDED MOST!

STRENGTH—*tremendous strength*—enables these Gisholt Ram Type Turret Lathes to take all the punishment you'll ever give them. No detail has been overlooked to assure the sturdiness for extra capacity—for heavy, multiple cuts up to the limit of tools without danger of breakage. This is strength of the enduring kind that means low upkeep, longer life, and dependable accuracy through long years of service.



1 Rigid, one-piece bed and headstock are cast integrally and stiffened with cross ribs, permitting the heaviest cutting loads without vibration. Heat-treated alloy gears are carried on taper and ball bearings throughout. Power is transmitted through a sturdy multiple disc clutch.

2 Bed ways, turret ways, gibs and clamps are hardened steel. Binder lever locks square turret in place, in effect as one piece with cross slide. Extended carriage wings prevent tilting. Broad cross slide provides rigid support for cutting tools.

3 Double beveled clamp ring binds turret rigidly to slide, relieves locating pin and bushings of all strain in taking heavy cuts. There is no chance for the turret to weave and lose accuracy. Protected gib lock keeps turret slide in exact alignment. Turret head is extra heavy with large protected bearing directly on ram.

GISHOLT MACHINE COMPANY • 1209 *E. Washington Ave., Madison 3, Wis.*

Look Ahead...Keep Ahead...With Gisholt Improvements in Metal Turning

GISHOLT

TURRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES • SPECIAL MACHINES

horizontal ram and the stripper ram is 24 inches, and the capacity 115 tons. The maximum daylight opening is 45 inches, and the width of the table 8 feet. The table has four T-slots running from front to back, and is machined for insertion of a stripper cylinder. ----68

Century Precision Boring Machine

The Model RC precision boring machine recently brought out by the Century Engineering Co., 5529 S. Vermont, Los Angeles 37, Calif., is specially designed to finish-bore holes up to approximately 2 1/2 inches in diameter, and can be used advantageously for a variety of special applications and set-ups. The working surface of the table is 6 1/4 by 33 1/2 inches. The table moves on dovetailed ways and has two T-slots, each 11/16 inch wide, and a coolant trough extending around the outer edge. The ways are provided with an automatic oiling system.

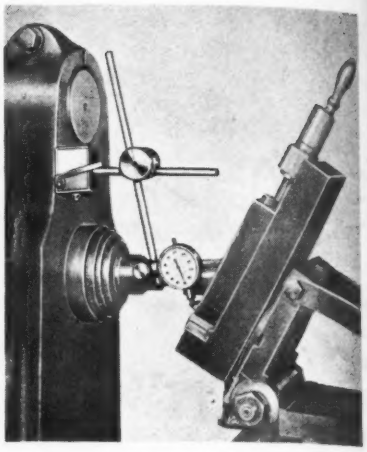
The spindle is mounted in four preloaded precision ball bearings and has a No. 5 Morse taper. Its center line is located 6 5/8 inches above the surface of the table. The three-step pulley provides spindle speeds of 650, 1300, and 2450 R.P.M., using a 60-cycle, 1/3- H.P., 110-volt motor mounted on a hinged plate designed to maintain the proper tension on the V-belt and to simplify belt shifting.

The air-hydraulic feed mechanism is of simple design, with all controls conveniently located in front of the machine. The boring feeds are variable through a wide range, and are accurately controlled by the metering valve. A second metering valve can also be supplied to control the return movement of the table so as to permit the forward stroke to be used for a semi-finish cut and the return stroke for finishing. The feed mechanism operates on an air pressure of 90 to 125 pounds per square inch.

The machine base is supported on three points, and can be mounted on either a bench or a floor stand. Arrangements can be made for an extra table slide to provide a cross-movement in addition to the longitudinal movement. The extra slide is designed to move on dovetail ways and is operated by hand through a rack and pinion. ----69

Magnetic Indicator Base

A magnetic base with supporting rods for any type of dial indicator has been brought out by the Main Electric Co., Inc., 1462 E. Main St., Rochester 2, N. Y. This new unit eliminates the need for a clamp, and permits mounting indicators in places where it would be difficult to hold them with any other type of base. The magnetic base is held tightly to iron or steel surfaces by means of two powerful "Alnico" permanent magnets. The strength of these magnets is ample to support the indicator at the extreme end of the mounting rod. ----70

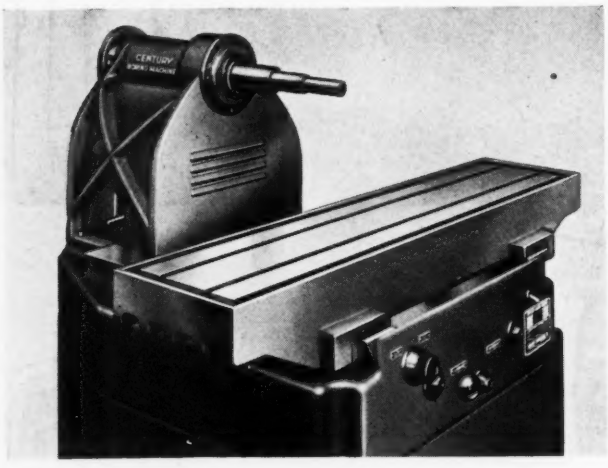


Magnetic Indicator Base Brought out by Main Electric Co., Inc.

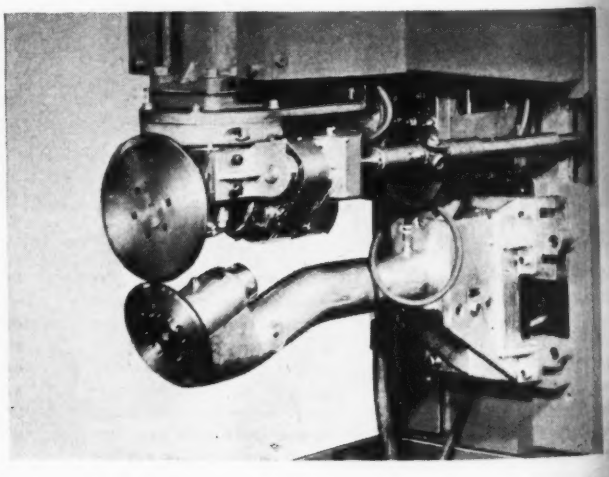
Thomson Seam-Welder Designed for Welding Close to Corners

A seam-welder designed for welding close to corners of box-shaped or other angular assemblies has been developed by the Thomson-Gibb Electric Welding Co., Lynn, Mass. As shown in the illustration, the lower welding wheel is in an angular position, which permits seam-welding close to corners of metal boxes, ducts, etc. When conditions require it, an angular set can be given to both the upper and lower welding wheels.

The welder illustrated has a gear-driven upper welding wheel and an idling lower wheel. A variety of



Precision Boring Machine Brought out by Century Engineering Co.



Thomson Welder Designed for Seam-welding Close to Corners

To obtain additional information on equipment described on this page, see lower part of page 214.

POINTS GOOD FOR *150 More Pieces!*

SUNICUT

Doubles Drill Life . . . Improves Finish . . . Increases Speeds

Round, perfect holes — 300 of them per drill grind — that's the present production rate on a certain drilling operation at this large plant. But the rate wasn't always that high . . . as the following facts of the case show.

Poor finish and short drill life had been common complaints of the operators. On the SAE 4140 steel being machined, 150 pieces were the maximum they could get per drill grind . . . the finish was rough, despite the use of a well-known high grade cutting oil. Finally, they made a change in cutting oil at the suggestion of a Sun Oil Engineer. They switched to clear, transparent, sulphurized SUNICUT.

100% improvement in drill life and much better finish were immediate results of the change. They are now able to drill 300 pieces before drills need regrinding. As an extra bonus they find SUNICUT permits increased spindle speeds . . . further stepping up their output.

Savings in time and money are direct result of the increased production and longer drill life made possible by SUNICUT in this plant. Similar savings are possible on many other metal-cutting operations in your plant. Why not consult with a Sun Oil Engineer today on selecting the right cutting oil for these operations. Call or write

SUN OIL COMPANY · Philadelphia 3, Pa.

Sponsors of the Sunoco News Voice of the Air — Lowell Thomas

SUN INDUSTRIAL PRODUCTS

HELPING INDUSTRY HELP AMERICA

driving arrangements are available. Gear or knurl drives can be applied to either the upper or lower wheel or to both welding wheels, as best suits the requirements of the work.

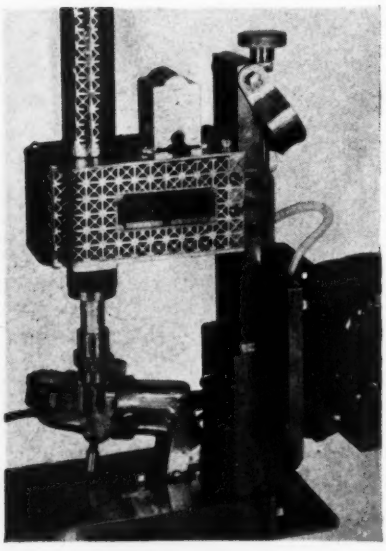
The angular arrangement of the welding wheels is shown on a Thomson Model 25 seam-welder equipped with double-acting air cylinder to supply the welding pressure and with variable-speed drive to provide an ample range of welding speeds. 71

Hardness Tester and Certifier

A hardness tester and certifier developed by the Glenn L. Martin Co. is being built by the York Electric Tool Co., York, Pa., to meet the specific needs of testing departments in any industry using aluminum, aluminum alloys, plastics, and similar materials. This tester is designed to eliminate visual inspection and to electrically certify and mark each piece passing the required tests. Materials not marked by the tester are rejected as not meeting specifications.

Provision is made in the tester design to accommodate the Government certification die and the inspector's die, so that they can be used in the same operation.

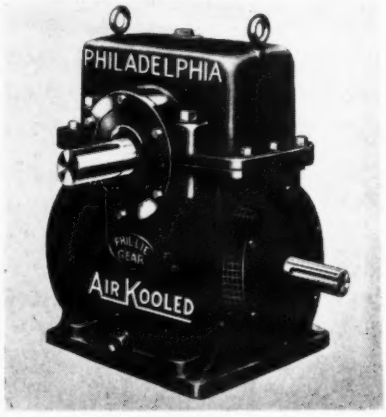
This tester has a meter counter which keeps an accurate record of pieces that pass inspection. Since each inspector's number appears on the test mark, carelessness is guarded against, as faulty work is easily traced to the inspector.....72



Hardness Tester and Certifier

Philadelphia "AirKooled" Worm-Gear Speed Reducer

The new "AirKooled" worm-gear speed reducer now being made by the Philadelphia Gear Works, Inc., Erie Ave. and G St., Philadelphia 34, Pa., has considerably higher horsepower ratings than the standard heavy-duty type unit for worm speeds ranging from 580 to 1750 R.P.M. At 1750 R.P.M., for example, the ratings are approximately doubled at all ratios. Horsepower ratings of standard worm-gear units at the higher worm speeds are limited due to the rise in temperature of the oil bath. The "AirKooled" unit dissipates the heat by drawing cooling air through the double-walled ribbed housing with



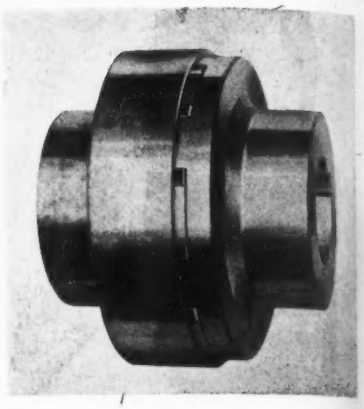
"AirKooled" Worm-gear Speed Reducer

a suction fan mounted on the worm-shaft.

At 1750 R.P.M., where the rating advantage is greatest, the "AirKooled" unit will be about two sizes smaller than a standard unit of the same capacity, resulting in a great saving in space and about a 40 per cent reduction in weight.....73

Lovejoy Protected Flexible Coupling

Protection that insures operators against the catching of clothing is embodied in a new L-R Type C shrouded flexible coupling announced to the trade by the Lovejoy Flexible Coupling Co., 5009 W. Lake St., Chicago 44, Ill. The essential feature of this new protecting device is the outside steel collar which holds the load cushions in place. An extension of this collar



Lovejoy Flexible Coupling with Protecting Collar

which encircles the coupling safeguards material and fingers from the heads of the bolts that secure the load-cushion retainer. The bolt heads are concealed, but are easily and conveniently reached when necessary.

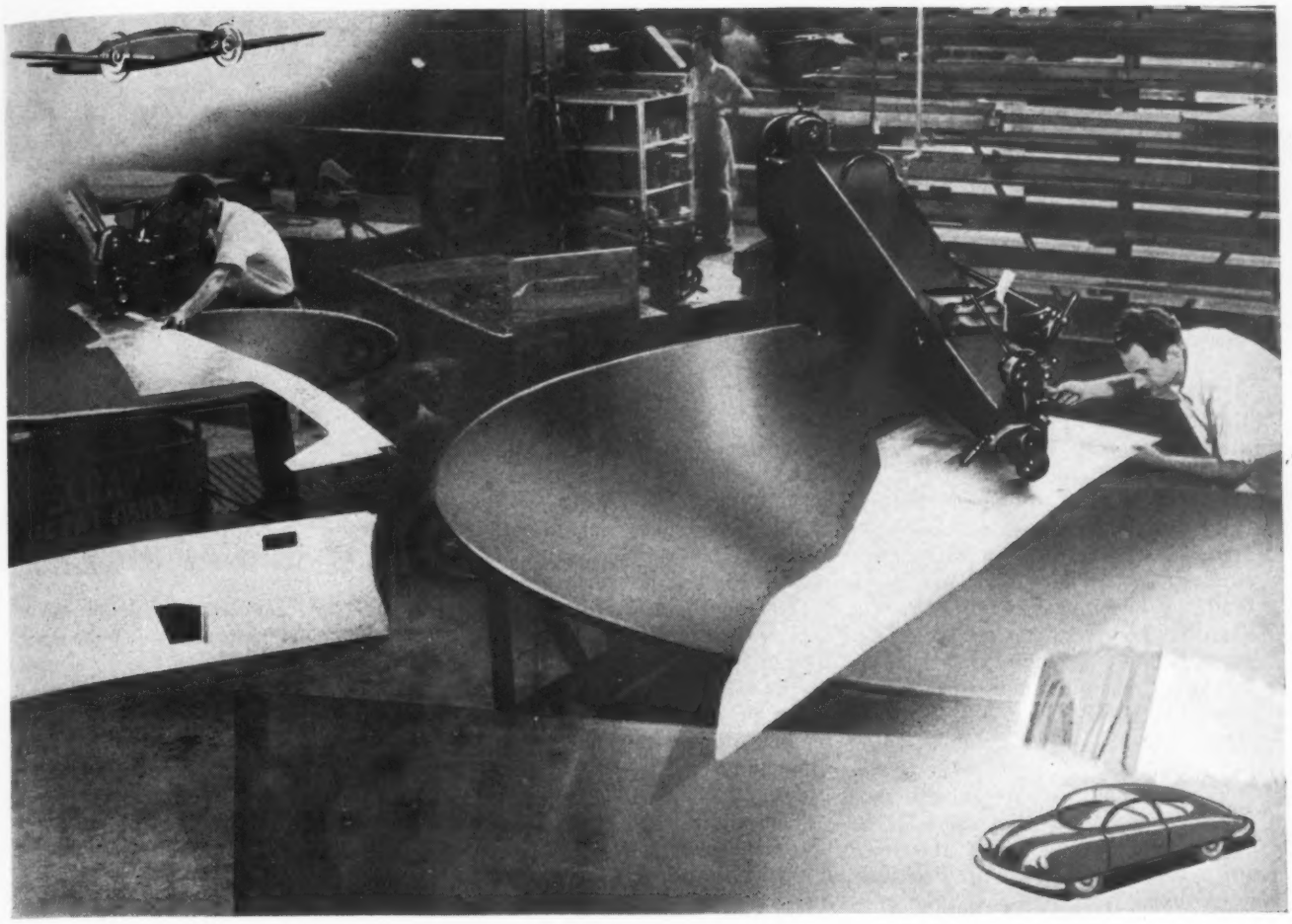
L-R flexible couplings of the Type C class are designed for heavy-duty service. Individual free-floating load cushions between the rugged jaws are held in position between an inside steel sleeve and the removable steel collar. Types are available for direct attachment to the flywheel. Drum and other types are available for rapid disassembly without disturbing the driving or driven equipment.

Cushions of various materials adapted to the particular service on which the coupling is used are free to be deformed sufficiently to meet every emergency—for correction of misalignment, protection from shock and vibration, and other transmission troubles that affect both driving and driven machinery. 74

Starrett "Safe-Flex" High-Speed Steel Hacksaw

The L. S. Starrett Co., Athol, Mass., has developed a hand hacksaw blade known as the "Safe-Flex," which has been designed for safe, dependable, and fast cutting even when the materials are hard and the cutting conditions severe. This new hacksaw is made of high-speed steel, so treated as to combine a soft, flexible back with a hard cutting edge. The result is a blade that is practically unbreakable under hard use or abuse, and one that has a long useful life.

To obtain additional information on equipment described on this page, see lower part of page 214.

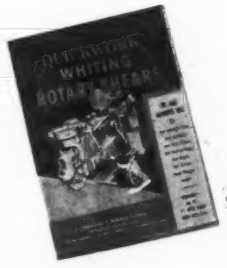


Produce parts for planes today— and for streamlined cars tomorrow

THERE'S NO RECONVERSION PROBLEM WITH THIS VERSATILE METALWORKING MACHINE

Your Quickwork shear will

Cut straight lines
Cut narrow strips
Cut circles
Cut bevelled edges
Cut openings
Cut irregular shapes
Joggle
Make clean cuts without burrs at high speed —in a single pass



Write for bulletin.

The coming reconversion to peacetime manufacturing will be quicker and less costly for manufacturers who look for a wide range of usefulness in equipment purchased now for war production purposes. Quickwork shears can turn out parts for planes or for the streamlined passenger cars of tomorrow with equal ease—and with the help of auxiliary attachments they joggle, flange, or cut straight lines, strips, openings, circles, or irregular shapes.

Quickwork shears may solve one of your special metalworking problems; investigate their possibilities today. Write for information.

QUICKWORK-WHITING DIVISION

WHITING CORPORATION

15673 LATHROP AVENUE, HARVEY, ILLINOIS

These hacksaws are furnished in 10- and 12-inch lengths. Blades with 14 and 18 teeth per inch have "alternate set" teeth, while blades with 24 and 32 teeth per inch have "wavy set" teeth. They are packed in the sturdy Starrett red box, especially marked to permit quick identification. 75

Haynes Cast Stellite Tool Tips

The Haynes Stellite Co., Unit of Union Carbide and Carbon Corporation, Kokomo, Ind., has brought out a line of tool tips cast from Haynes Stellite cobalt-chromium-tungsten alloy for use in shops desiring to fabricate their own metal-cutting tools. Metal-cutting tools made by brazing these tips to steel shanks are recommended for jobs employing tools having large cross-sections, tools that are bent or offset, or tools used in tool-holders in which the use of solid tools is impractical.

Tipped tools are particularly useful for operations that necessitate considerable overhang of the tool, since the Stellite tool tip provides a red-hard, abrasion-resistant cutting edge, and the steel shank to which the tip is brazed provides the strength and toughness necessary to withstand the strain resulting from such operations.

Ten standard shapes of tool tips are available in each of ten standard sizes, cast from either 98M2 or Star J-Metal alloy. Each has the joint faces at the bottom and one end bronze-tinned for brazing. Standard tips can also be furnished without the bronze coating if desired. Stock is allowed on standard tips for finishing to the nominal size. 76

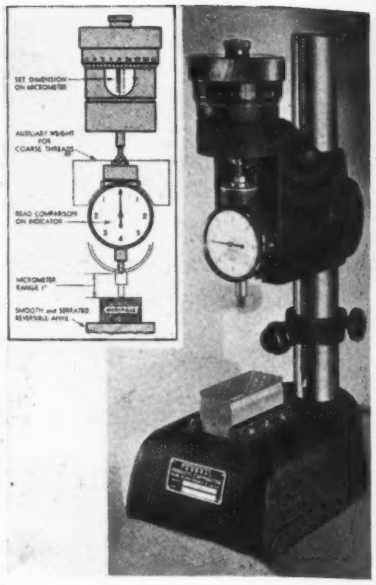
Federal Micro-Comparator with Micrometer Head

A combination micrometer and dial indicator comparator designed for production inspection and miscellaneous tool-room use has been brought out by the Federal Products Corporation, 1144 Eddy St., Providence 1, R. I. The exceptional versatility of this instrument makes it especially useful in tool-rooms and small shops that have to gage miscellaneous job lots of duplicate pieces. The dial indicator comparator can be employed for gaging work at a fast rate, and is claimed to give uniform readings even when used by different operators.

The micrometer head reading directly to 0.0001 inch on the thimble eliminates the need for a complete set of gage-blocks for setting the dial indicator to the required dimension. The 1- and 2-inch gage-blocks furnished as extra equipment permit setting the gage by means of the micrometer to any dimension within the measuring range.

The micrometer head facilitates inspection of thread pitch diameters by the three-wire method. An auxiliary weight provides the additional pressure required for the coarser threads. This weight and a chisel-shaped sensitive contact anvil are furnished as extras. A Federal super-sensitive low-friction dial indicator having 0.0001 inch graduations and high repetitive accuracy is furnished as regular equipment.

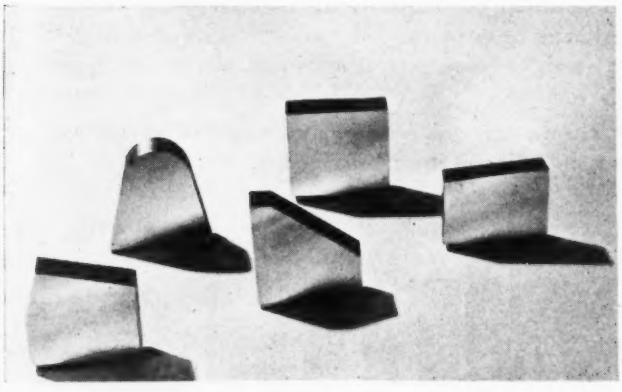
The Micro-Comparator is also used for direct measuring with a constant contact pressure by setting the dial indicator at zero and using that as a reference point. The sensitive contact diamond point is 3/16 inch in diameter and has a 3/32-inch contact radius. Boron-carbide contacts can also be furnished if desired. The maximum vertical capacity measured from the sensitive contact point to the reference anvil is 8 inches, and the maximum throat depth 3 7/8 inches. The reference anvil has a reversible, ground and lapped surface 3 3/16 by 1 1/2 inches. The instrument has a base 6 1/2 by 10 inches, is 18 inches high, and weighs about 62 pounds. 77



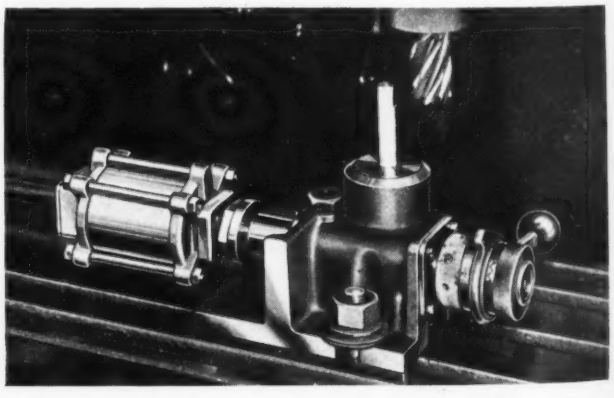
Federal Combination Micrometer and Dial Indicator Comparator

Air- or Hand-Operated Collet Chucking Fixture

An improved collet chucking fixture which permits changing quickly from air to hand operation, or vice versa, has been added to the line of collet fixtures made by the Wayne Pump Co., Fort Wayne 4,



Haynes Stellite Tool Tips Available in Ten Sizes



Wayne Collet Chucking Fixture Applied to Jig Borer

To obtain additional information on equipment described on this page, see lower part of page 214.

How "harmless" fingerprints get metal in trouble...

"Synthetic fingerprints" on steel plates reveal (left) excess rusting where standard solution was placed on plate, and (right) protection afforded on lower part of plate dipped in Cosmoline 805.

Fingerprints may be helpful to the police, but they're harmful to finished steel surfaces, handled between plant operations by perspiring workers.

Houghton has developed a fingerprint neutralizer which, when tested by a government agency against nine other preparations offered, showed "superior fingerprint neutralizing properties".

Cosmoline 805, which fulfills the requirements for neutralization set forth in Army Service Forces Manual M-406, does more than combat the acid effect of perspiration residue. It neutralizes other acid contaminants, such as from pickling or plating. It displaces water. It leaves a thin protective film which prevents intra-plant corrosion, and which can be left on the steel when a permanent preventive is applied before shipment. For full details and prices, see The Houghton Man or write E. F. HOUGHTON & CO., Philadelphia 33, Pa.

Houghton's **COSMOLINE** *805*

Ind. The same four-piece blank collet that was a feature of previous models is incorporated in the new fixture. The user of this fixture simply drills the collets to any desired size up to 9/16 inch in the case of work that passes through the collet, or up to 1 inch in diameter if the depth of the clamping cavity is not more than 3/4 inch.

The collet is designed to fit into a pull-down holder operated either by hand-lever or air motor. The collet parts are held together by a snap ring. Any number of interchangeable collets can be furnished for use in this holder. Application of the air motor for clamping requires only a few simple adjustments. The air motor is available with a valve operated in synchronism with the operation of the machine, so that both of the operator's hands are free for handling the work. The chucking jaws are made of tool steel, and can be hardened after drilling, if desired. The base of the fixture is 4 1/2 by 6 inches by 4 1/8 inches high.....78

"Speedaire" Worm-Gear Reduction Unit

The Cleveland Worm & Gear Co., 3276 E. 80th St., Cleveland 4, Ohio, has just brought out a "Speedaire" worm-gear reduction unit incorporating a fan cooling system which permits a pronounced reduction in the size of the unit required for a given horsepower output without departing from the rugged construction of previous Cleveland units.

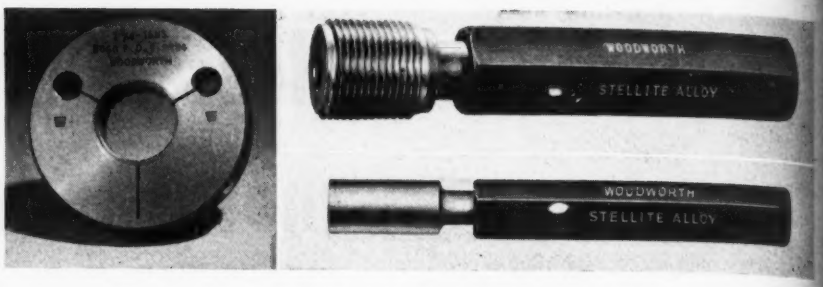
Application of fan cooling to the "Speedaire" unit is based upon a new type of double wall construction which provides an air passage that completely envelops the oil reservoir in which the gearing operates. The inner housing wall, forming the oil reservoir, is deeply finned on the air side, as shown in Fig. 2, to increase the area of the heat dissipating surfaces.

An exhaust fan located on the coupling end of the worm-shaft draws air at high velocity through the space between the housing walls from a grille at the opposite end of the unit. This fan is designed to operate with either direction of rotation. The effect of the double wall construction is to maintain a uniform flow of cooling air against the fins and housing wall over the whole oil reservoir surface, and thus utilize the full heat transfer efficiency of the system.

The operating temperature is lowered by this high-velocity air stream to such an extent that the "Speedaire" unit has much greater load-carrying capacity than a standard worm-gear unit of equal size and speed rating.....79

Fig. 1. "Speedaire" Worm-gear Reduction Unit Made by the Cleveland Worm & Gear Co.

Fig. 2. View of "Speedaire" Worm-gear Reduction Unit Showing Fan Cooling System



Woodworth Stellite Gages. (Left) Plain Ring Gage Consisting of Stellite Bushing in Aluminum Ring. (Upper Right) Stellite Thread Plug Gage. (Lower Right) Cylindrical Plug Gage of New Stellite Alloy

Woodworth Gages of Stellite Alloy

After a long period of experimentation to determine the most satisfactory material and design for plug and thread gages, the N. A. Woodworth Co., 1300 E. Nine Mile Road, Detroit 20, Mich., has brought out a line of gages made from dense castings of a new Stellite alloy. This new cobalt-chromium-tungsten alloy is said to be one of the hardest and most wear-resistant Stellite alloys. It is claimed that the gages made from this material are setting new records for wear resistance and accuracy, and are also showing additional advantages as a result of other characteristics of the hard stainless metal.

In one large plant having difficult production gaging problems, a Woodworth Stellite alloy 1/2-20 thread gage successfully performed the gaging operations on 3225 to 3903 pieces before it was necessary to replace the gage, as against an average life of 250 pieces for a steel gage. In another instance, a 0.6845-inch cylindrical Stellite gage used on a cast-bronze part was worn only 0.000025 inch after having gaged 18,518 holes, as compared with the gaging of but 4000 holes for a similar amount of wear on a chrome-plated gage.

Plain ring gages of Stellite alloy, such as shown to the left in the accompanying illustration, are made in a size as small as 0.150 inch. They consist of a Stellite bushing inserted in an aluminum ring. The smallest thread ring gage of this type has a major diameter of 7/8 inch, and consists of a Stellite bushing in an outer ring of steel. The 1-inch 14-thread plug gage shown in the view in the upper right-hand corner of the illustration was used by an automobile manufacturer for

To obtain additional information on equipment described on this page, see lower part of page 214.

the black widow carries a deadly sting

A DARK shadow streaks across the night sky. A newcomer enters the battle on the side of Democracy. Bearing a lethal sting, the Black Widow, America's newest night fighter, packs the power to destroy anything that flies. Swift as an arrow, formidable as its famed namesake, this new ship, designed by Northrop, in co-operation with the Army Air Force's Matériel Command, promises a deadlier weapon to the men who are bringing victory to the United Nations.

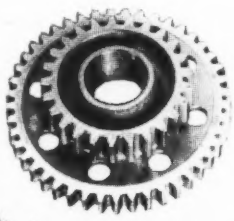
And in the Pratt & Whitney engines that drive this most powerful of all pursuit planes are Foote Bros. Gears—gears that of necessity meet new standards in metallurgical and dimensional perfection.

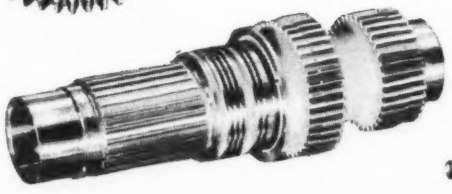
The Black Widow forecasts a new conception of design for the world of tomorrow—an era where high speed, the demand for greater efficiency, will find new uses for high precision gears. The engineering skill, production technique, manufacturing know-hows that have made possible the mass production of gears of such high precision may suggest applications in the development of machines you are designing for a world at peace.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 5225 S. Western Blvd., Chicago 9, Ill.

FOOTE BROS.

Better Power Transmission Through Better Gears





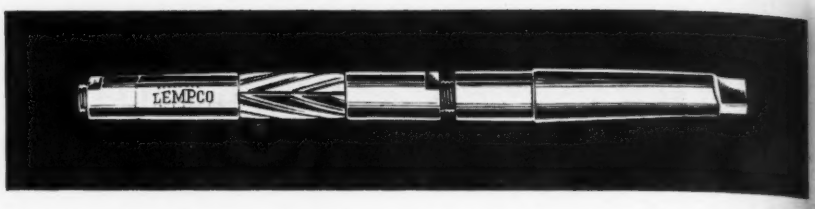
gaging 3192 pieces made of SAE 41-40 steel before being worn down to the low limit. This compares with an average gaging life of 1200 pieces for a steel gage. The cylindrical plug gage shown in the lower right-hand corner is 0.6845 inch in diameter. After gaging 16,000 cast-bronze pieces, this gage showed no appreciable wear. The average life of a chrome-plated gage on this job is 4000 pieces.

Cylindrical and thread plugs up to and including 3/4 inch outside diameter are made solid, both the gage member and shank being cast from solid Stellite. In order to conserve vital Stellite and to reduce the weight as much as possible, gages above 3/4 inch in diameter and including 1 1/2 inches in diameter are of the bushing type with a standard tapered steel shank brazed to the Stellite bushings. This results in a practical and economical gage which otherwise conforms to the American Gage Design Standard. 80

Precision Pin Gages

Precision pin gages in number and letter drill sizes and in fractional inch sizes, comprising complete sets packed in strong cabinets, are being placed on the market by the United Precision Products Co., 3524 W. Belmont Ave., Chicago 18, Ill. Number drill sizes ranging from 1 to 60 and letter drill sizes ranging from A to Z comprise a group of eighty-six pins. Fractional sizes from 1/64 to 1 inch, varying in size by 1/64 inch, constitute another group of sixty-four pins. These pin gages are made of the finest quality gage steel, hardened to 60-63 Rockwell C scale, and are accurately finished by precision lapping. They can be made with tolerances to suit requirements.

Brass strips with letter, number, or fractional size permanently fixed in clear, easily read white characters identify each gage in the cabinet. The smaller pins are kept in glass vials with heavy plastic screw tops. The cabinets are 9 7/8 inches wide, 15 1/2 inches long, and 4 1/2 inches high. 81



"Dual-Spiral" Expansion Reamer Made by Lempco Products, Inc.

Lempco Hi-Speed Steel Expansion Reamer

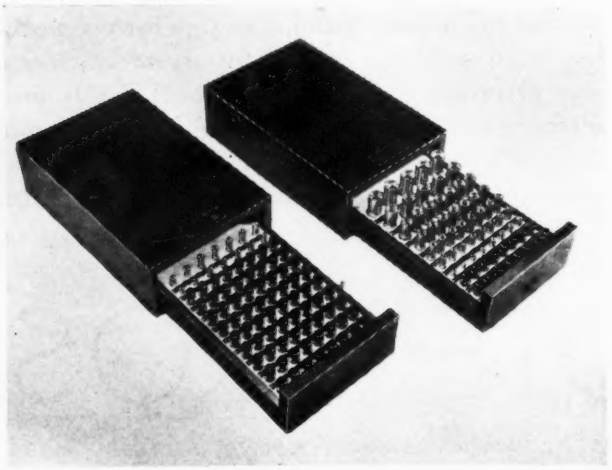
The Model R Hi-Speed steel "Dual-Spiral" expansion reamer recently brought out by Lempco Products, Inc., 5700 Dunham Road, Bedford, Ohio, has an adjusting lock-nut designed to hold the three cutting-blade segments rigidly and prevent any possibility of reaming a bore over size, even when the blades are subjected to excessive pressures. Two of the three segment blades have helical cutting edges of the same hand, while the helical cutting edges of the third segment are of the opposite hand.

It is claimed that the right- and left-hand helical cutting edges of this reamer provide a shearing action that finish-reams any machinable ferrous or non-ferrous metal to a mirror-smooth surface. Equally good results are said to be secured in reaming phenolic, formaldehyde, and other fibrous plastics.

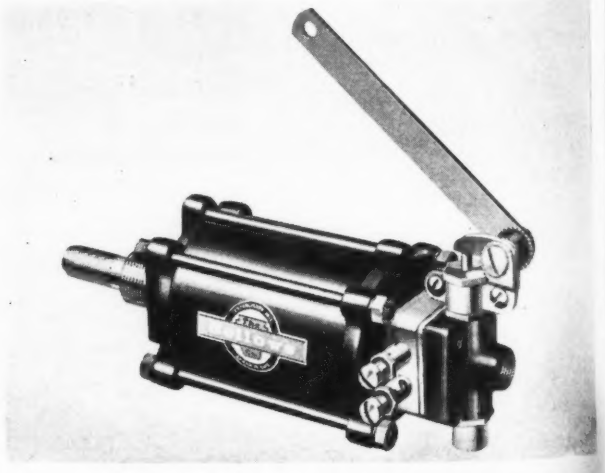
The removable blades can be easily resharpened, and are said to maintain their size and cutting edge exceptionally well. The design provides for accurate straight-line expansion of from 0.035 to 0.080 inch. Extensions, pilots, and taper bushings are available for line-reaming. The reamers can be had with Nos. 1 to 5 Morse taper shanks or butt shanks. 82

Bellows Air Motor Designed to Motorize Hand-Operated Units

Many hand operations can be made fully automatic by the simple application of a Model BM air motor just placed on the market by the Bellows Co., Akron, Ohio. This is an improved type of the Bellows-Senacon air motor now used in many plants to speed up production on machine tools. It will perform

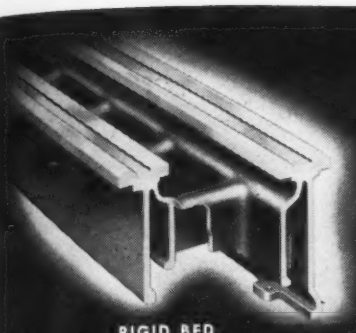


Pin Gages Placed on the Market by the United Precision Products Co.

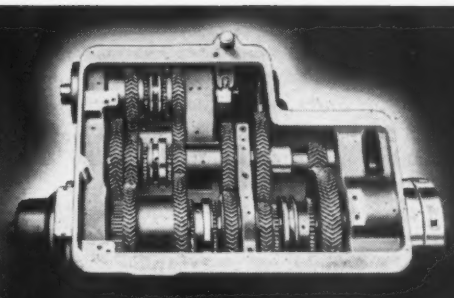


Bellows Self-contained Air Motor for Motorizing Hand-operated Units

To obtain additional information on equipment described on this page, see lower part of page 214.



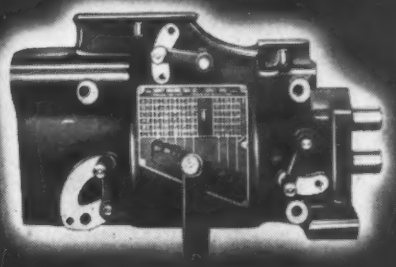
RIGID BED CONSTRUCTION



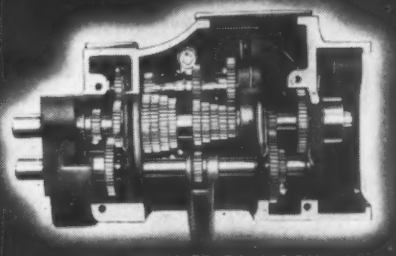
CONTINUOUS TOOTH 30° HELIX HERRINGBONE GEARED HEAD

Sidney

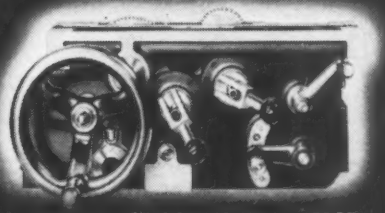
40TH ANNIVERSARY



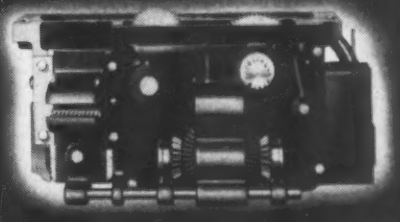
FRONT VIEW OF GEAR BOX



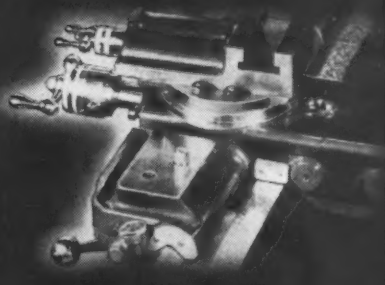
REAR VIEW OF GEAR BOX



FRONT VIEW OF DOUBLE WALL APRON



REAR VIEW OF DOUBLE WALL APRON



SIDNEY COMPOUND REST

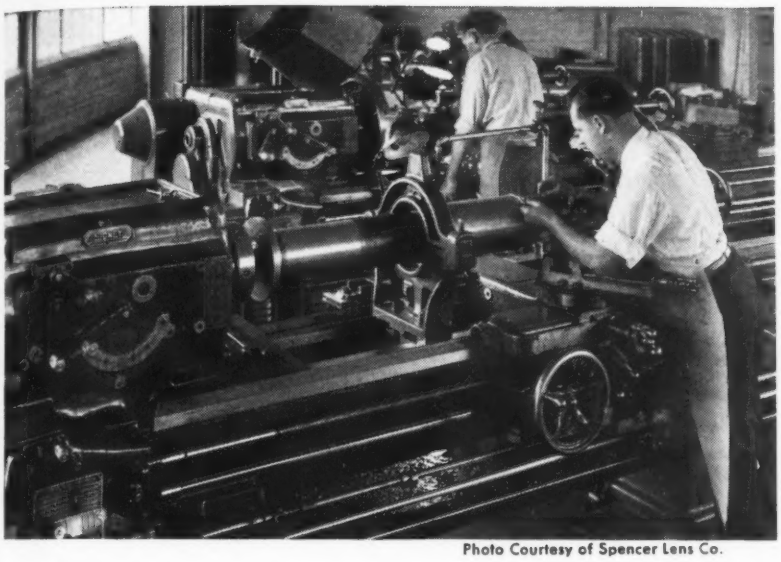


Photo Courtesy of Spencer Lens Co.

For close tolerance work

SIDNEY LATHES

The versatility of Sidney Lathes is demonstrated here where two of the battery of Sidney lathes shown are handling distinctly different jobs—quickly—accurately—easily.

The sturdy bed construction—the perfect alignment of the component parts—the smooth flow of power from the continuous tooth Herringbone Geared Headstock assure continued accuracy and fine finish on all jobs.

When your work calls for extremely close tolerances—for high speeds and heavy feeds—for smooth dependable finish—put it on a Sidney Lathe.

Full descriptive bulletins on all sizes immediately available.

SIDNEY

The SIDNEY MACHINE TOOL Company

Builders of Precision Machinery

SIDNEY ESTABLISHED 1904 OHIO

such operations as feeding work to tools or tools to work, opening and closing vises and holding fixtures, and operating clutches and latches. It also provides a convenient source of flexible power for staking, clamping, and embossing operations.

This air motor is a complete self-contained power unit with integral valve, operating lever, and speed control. The valve-operating lever is adjustable to any angle and any plane, and is easily synchronized with the machine cycle by simple linkage, cam, or solenoid control to obtain full automatic operation. Dual exhaust throttle controls provide stepless speed regulation of the piston-rod in either or both directions. The exhaust air can be utilized to eject parts from holding devices or to clean chips and dirt from the work area.

The motor operates on any air pressure up to 175 pounds per square inch. The power thrust pressure is approximately five times that of the operating air line pressure. The motor is available in stroke capacities ranging from 1 1/2 up to 48 inches.....83

Pope Motorized Grinder Spindle

The Pope Machinery Corporation, 261 River St., Haverhill, Mass., has developed a motorized grinding spindle employing a G-E motor of 1 H.P. The motor operates in a sealed housing designed to assure the maintenance of accurate balance and efficient operation for the life of the large S K F double-row sealed-in roller bearings. This new grinder spindle has been developed to give an exceptionally fine surface finish, and at the same time, to speed up grinding work where a large amount of surplus metal must be removed.

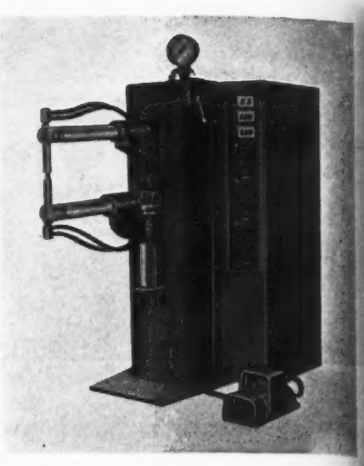
The spindle can be operated vertically, horizontally, or at any desired angle. The design of the solid shaft extension can be readily varied to provide for mounting special tool-holders or standard drill chucks. It is intended for regular use on 6- by 18-inch surface grinders, but can also be used on boring mills, planers, milling machines, and other machine tools for special work. 84

Sciaky Air-Operated Spot-Welder

A new air-operated rocker-arm type spot-welder for the production welding of sheet-metal work has been announced to the trade by Sciaky Bros., 4915 W. 67th St., Chicago 38, Ill. This relatively small self-contained unit employs features usually found only on larger machines. The upper arm is equipped with heavy-duty roller bearings at the fulcrum point, and the pressure cylinder has a bumper designed to eliminate hammering.

Electronic controls and contactor are mounted in a hinged cabinet with conveniently located dials and switches. Current interruption can be effected either magnetically or by ignitron tubes. Operation is fully automatic, with controls for welding heat, duration of current application, cooling period, etc.

The welder rating is 30 KVA operating on a 50 per cent duty cycle. The welding capacity on mild steel ranges from two thicknesses of 0.016 inch up to two thicknesses of 0.080 inch. Stainless-steel sheets up to 0.040 inch thick can be welded. Spot-welds can be made at the rate of 180 per minute on two thicknesses of 0.032-inch pickled mild steel. The pressure exerted by the electrode at the throat depth of 24 inches is 1000 pounds.....85



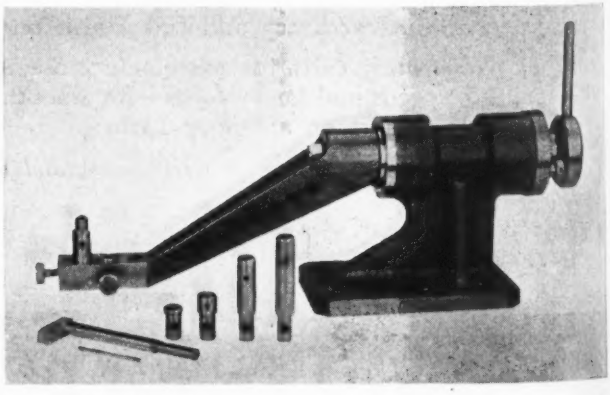
Sciaky Air-operated Rocker-arm Type Spot-welder

Radius Dresser for Grinding Wheels

A Model No. 45 precision radius dresser with a capacity for dressing or forming grinding wheels to any radius up to 4 1/2 inches has been announced to the trade by the U. S. Tool & Mfg. Co., 6906 Kingsley, Dearborn, Mich. This dresser is furnished with diamond-holder bushings of three different lengths, which assures ample support for the diamond when small or large radii are being formed. The dresser is equipped with Timken taper bearings, and is carefully balanced to eliminate vibration.

Graduations etched on a chrome-plated metal ring, together with a

Motorized Grinder Spindle Developed by the Pope Machinery Corporation



Radius Dresser for Grinding Wheels, Made by the U. S. Tool & Mfg. Co.

To obtain additional information on equipment described on this page, see lower part of page 214.

New!
Ozalid Rapid Black
MARCH 1944

Now!

Ozalid Transblack

the first *black-line, dry-developing intermediate* paper

Until now, you've been using a sepia-line paper to produce "intermediate originals" of your engineering drawings.

For until now, no manufacturer in the field has been able to create a satisfactory *black line* intermediate.

Now, Ozalid proudly offers—OZALID TRANSBLACK . . . with all of these desirable characteristics:

1. **Covering Power.** The lines of an Ozalid Transblack intermediate possess high actinic density, and produce *sharp prints without loss of detail.*

2. **Maximum Visual Density.** An Ozalid Transblack intermediate is easier to read and work on. Furthermore, since additions in pencil or pen *match the printed lines,* subsequent prints are more uniform than those produced from a sepia intermediate with black additions.

3. **Speed.** Ozalid Transblack intermediates can be made at fast speeds from average originals . . . and will produce subsequent prints at speeds *fast* for intermediates.

4. **Permanence.** Ozalid Transblack intermediates are *non-yellowing* and resistant to light and chemical action. Even after being filed away for years, they will produce excellent prints.

5. **No Increase in Price.** Ozalid Transblack sells at the same price as sepia papers. Before ordering, however, send for a FREE sample package. A test in your machine will convince you of Transblack's superiority.

*OZALID *RAPID BLACK* IS RECOMMENDED for producing the best "work" prints from originals or intermediate originals.

OZALID PRODUCTS DIVISION
GENERAL ANILINE & FILM CORPORATION
Johnson City, N. Y.

Gentlemen:

☐ Send a FREE sample package of OZALID TRANSBLACK for test purposes.

☐ Send printed samples of OZALID TRANSBLACK and OZALID RAPID BLACK.

ALSO catalog explaining Ozalid Process.

Name_____

Company_____ Title_____

Address_____

OZALID IN CANADA—HUGHES OWENS CO., LTD., MONTREAL

lock-stop on the spindle, provide means for exactly locating the radius on the wheel being dressed. The complete dresser weighs 58 pounds. 86

DoAll Line of Precision Gage Instruments

A complete line of DoAll gage instruments developed to meet the demand for a broader application of gage-blocks has been brought out by Continental Machines, Inc., 1312 Washington Ave. South, Minneapolis 4, Minn. The instruments in this line are made with the same accuracy as the precision gage-blocks, and make possible a greater variety and range of precision measurements than would be possible with the gage-blocks alone. The twenty instruments in this set, in combination with a complete set of gage-blocks, can be used for practically all measurements required for inspection work.

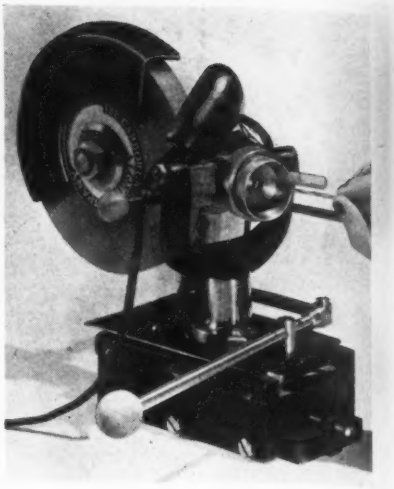
With the gage-holders and caliper bars of this set any type of "Go" and "No Go" snap gage can be made up in a matter of seconds. Gages thus assembled are as accurate and as easy to use as standard snap gages. The set also includes instruments for use as precision height gages, which have been designed to meet all the requirements of standard height gages but with a much higher degree of accuracy.

Trammel points and center points for checking lay-outs, scribing arcs or parallel lines, and checking center distances or the lead of a thread are included in the set. Determining the flatness of finished work is provided for by two quartz optical flats and a high intensity monochromatic light. The 5-inch sine bar enables angles to be checked to an accuracy of four seconds. The set also includes an adjustable vernier gage with complete block combinations to be made up in increments of 0.00001 inch. Each instrument in the set can be supplied separately in a wooden case designed to protect its precision surfaces. The full set of instruments is available as a complete inspection laboratory unit enclosed in a walnut case. 87

Set of DoAll Precision Gage Instruments Available as a Complete Laboratory Inspection Unit

Tombill Drill-Sharpening Attachment

The Mercury Products Co., 423 Euclid Ave., Cleveland 14, Ohio, is manufacturing an attachment for sharpening small twist drills ranging in size from No. 70 to 15/64 inch in diameter. The design of this Tombill sharpening attachment is unique in that no cams are employed, every rotating movement being on centers under spring tension. This attachment can be used with grinding wheels not larger than 6 inches in diameter.



Tombill Drill-sharpening Attachment Made by Mercury Products Co.

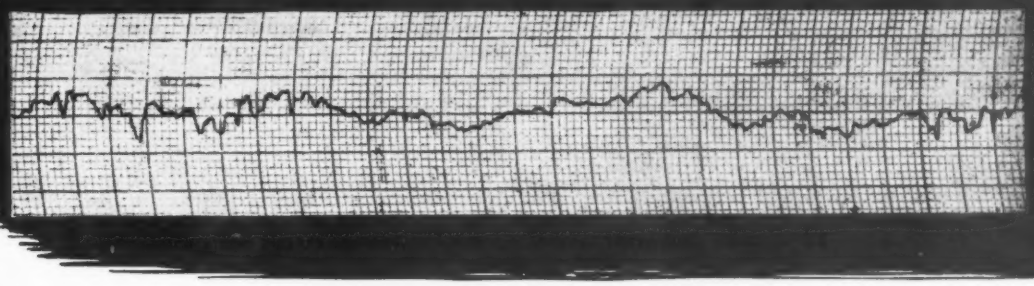
Sharpening a drill with this attachment is accomplished in four simple steps: First, the drill is inserted and the chuck tightened; second, the operator, looking through a magnifying glass, lines up the drill lip to be ground with the alignment bar; third, the grinding bar is slowly depressed and then released; last, the chuck is revolved for grinding the other lip of the drill, and the third operation repeated. Each size drill requires a separate bushing, ten of which are supplied. 88

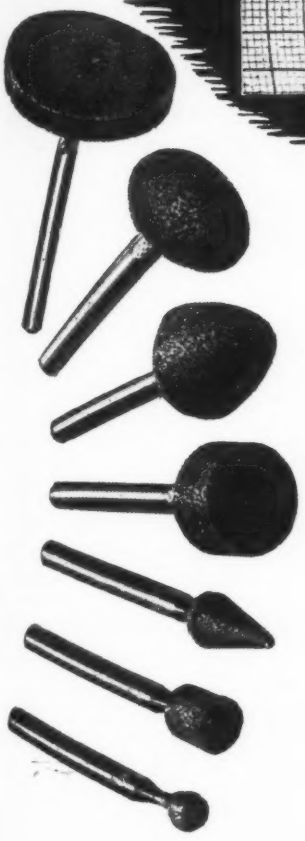
Jones Heavy-Duty Polishing Lathe

A polishing lathe for heavy-duty work, known as the No. 143, has been brought out by the Jones Engineering Co., Ellwood City, Pa. The machine is designed for either bench or stand mounting. It is a production machine, using two contact rolls equipped with fast cutting endless abrasive belts. The rolls are 14 inches in diameter and have a 3-inch face. The spacing between the inside faces of the wheels is 24 inches, and the distance from the base to the center of the shaft is 9 inches. The driving motor is mounted underneath the bench or stand to protect it from dust and dirt. 89

To obtain additional information on equipment described on this page, see lower part of page 214.

Proof of a Better Finish





Surface Analyzer Tape Proves you Get a Better Finish with Chicago Wheels

These results were obtained at a rate of 10 pieces per hour in an aircraft parts plant. Material, X-13-15, Rockwell 60 to 57, grinds out .006 to .007 stock. Chicago Wheel used, 1/2 x 1/2 x 1/8", Grain 180, Grade L Arcite FV Bond. Spindle Speed 40,000 r.p.m. Lapping and super finishing eliminated on this job.

Can you match that finish? Sounds phenomenal, but you can do it with Chicago Wheels. And, the secret of their superiority lies in the new FV Bond, developed exclusively for Chicago Wheels, after 50 years' experience making wheels for the most accurate and precise applications.

Here's What FV Bond Will Do For You

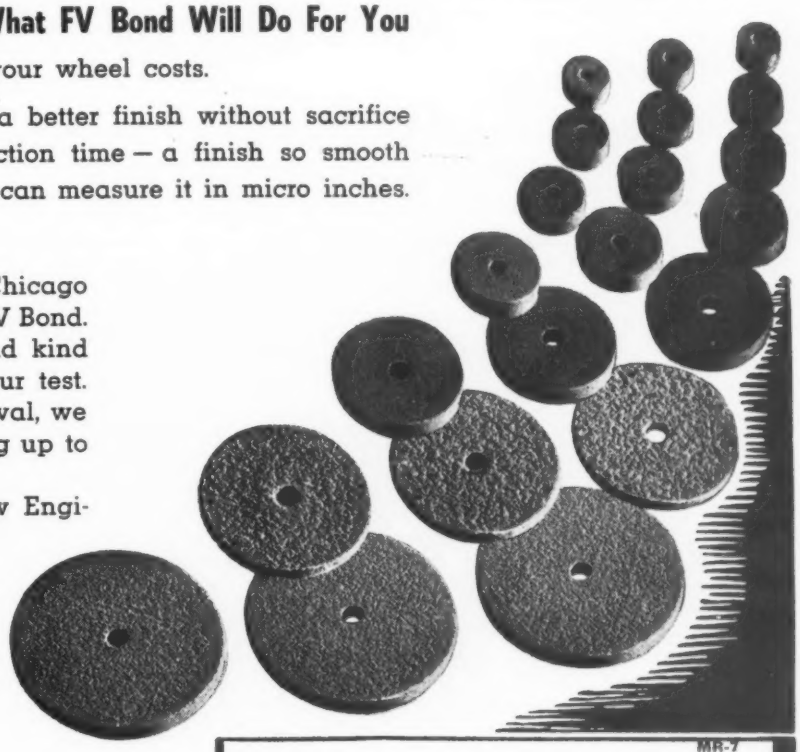
- Reduce your wheel costs.
- Produce a better finish without sacrifice of production time — a finish so smooth that you can measure it in micro inches.

TRIAL WHEEL FREE!

Write or send the coupon today for a Chicago Wheel, made with this remarkable new FV Bond. Tell us grinder you use, size wheel and kind of material on which you will make your test.

For the duration, with full WPB approval, we are specializing on small sizes—anything up to 3" in diameter.

Write for Catalog and one of the new Engineering Survey Forms, a step in the direction of better finishing.



ARMY E NAVY
MOUNTED WHEELS
SMALL GRINDING WHEELS

Half a Century of Specialization has Established our Reputation as the Small Wheel People of the Industry.

CHICAGO WHEEL & MFG. CO.

America's Headquarters for Mounted Wheels and Small Grinding Wheels

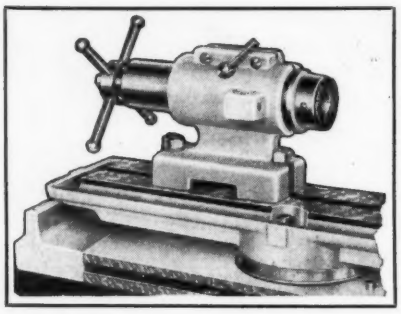
1101 W. Monroe St. Dept. MR Chicago 7, Ill.

MR-7

Send Catalog and Survey Form. Interested in ☐ Mounted Wheels. ☐ Grinding Wheels.
☐ Send Test Wheel. Size .....

Name.....

Address.....



K. O. Lee Tap Grinding Fixture

Tap Grinding Fixture for Use on Tool-Grinders

The K. O. Lee Co., Aberdeen, S. D., is now producing a new tap grinding fixture which is adaptable to any make of tool-grinder. This compact, sturdy unit is designed for maximum accuracy in grinding taps through the use of collets. It will accommodate taps from No. 8 to 2 1/2 inches in diameter.

All grinding operations necessary for sharpening taps can be accomplished with one set-up; these include grinding the relief, grinding the flutes, and salvaging broken taps. Either right- or left-hand taps with two, three, four, five, or six flutes can be ground. T-slot blocks to fit any make of tool-grinder can be furnished.....90

Atlantic Emergency Plug Gage Blanks

The George Scherr Co., 199 Lafayette St., New York 12, N. Y., has just brought out a set of thirty-six cylindrical plug gage blanks made in sizes of from 0.029 to 1.000 inch in diameter, varying in steps of 1/16 inch. This emergency set permits a plug gage of any size within its range to be produced in a few minutes on a cylindrical grinding machine. The blanks are oil-hardened throughout, and have finish-ground shanks and a lapped center at each end. Thus commercial finish gages can be easily produced by grinding the blanks to the required sizes. 91

Landau Sensitive Multiple-Spindle Drilling Head and Draw-In Collet Chucks

The sensitive multiple-spindle drilling head shown in Fig. 1, and the draw-in collet chucks shown in Fig. 2, are new products of the Landau Machine Co., 545 Fifth Ave., New York 17, N. Y. The drill head is provided with five drilling spindles, and is adapted for use on bench drills. The main drive is centrally located, mounted in ball bearings, and has a No. 2 taper socket which absorbs the full thrust or load capacity of the entire head.

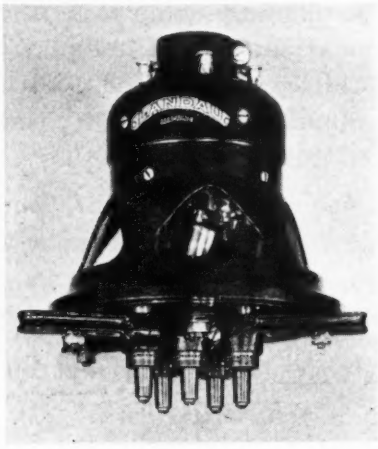


Fig. 1. Landau Adjustable Multiple-spindle Drilling Head

Each spindle is a complete unit, has a double bearing, and can be easily set to any desired position by simply loosening the nut that holds the spindle arm in the circular frame. The spread adjustment of the spindles ranges from 5/8 inch to 4 inches. The head weighs 4 1/2 pounds, is 5 inches high, and provides for spindle speeds up to 3000 R.P.M. The spindles will take drills up to 3/16 inch in diameter.

The Type A draw-in collet chuck with No. 3 taper shank, shown at the right in Fig. 2, can be used in any lathe or dividing head for milling or other precision operations. The chuck will take standard threaded collets of any size up to 1/2 inch. The length of the head is 1 7/8 inches, and the diameter 2 1/4 inches.

The Type B collet chuck, shown at the left in Fig. 2, operates on the same principle as the Type A chuck, and is designed to fit any spindle having a standard threaded nose. It will take 5/8-inch stock, and is provided with interchangeable threaded bushings to accommodate short or long collets. The chuck head is 1 3/4 inches in diameter and 7/8 inch long. This chuck, like the one shown at the right, is opened and closed by means of a handwheel on the chuck nose.....92

Stellite Round Tool Bits

Round tool bits made either from Stellite 98M2 or Stellite Star J-Metal alloy have been brought out by the Haynes Stellite Co., Unit of

Atlantic Plug Gage Blanks Brought out by the George Scherr Co.

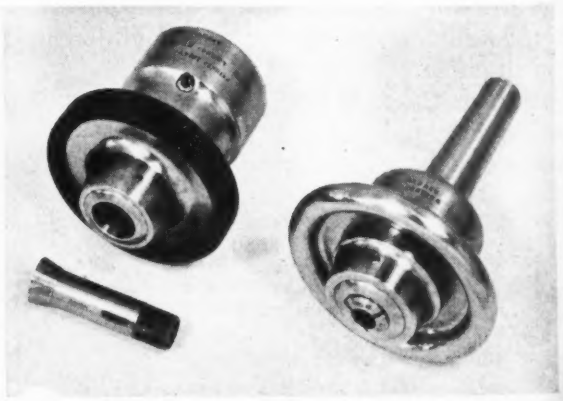


Fig. 2. Landau Draw-in Collet Chucks with Taper and Threaded Shanks

To obtain additional information on equipment described on this page, see lower part of page 214.

IT'S LIKE GIVING YOUR ASSEMBLY LINE A SHOT IN THE ARM

TO SWITCH TO THE SCREWS WITH THE ENGINEERED RECESS THAT SPEEDS UP ASSEMBLY AS

MUCH AS 50% IT'S PHILLIPS

Manufacturers in every industry can tell you that switching to Phillips Recessed Head Screws acts like a tonic to assembly lines.

To start with, you get faster – *much faster* – screw driving. Comparisons made in scores of plants prove that Phillips Screws step up fastening speed as much as 50%.

Next, Phillips Recessed Head Screws save precious man hours. The scientifically Engineered Recess utilizes the worker's full turning power and skill. Time and muscle are not wasted on wobbly starts, slantwise drives and dangerous driver skids – nor on correcting sloppy work.

Finally, with all this increased speed, you get vastly better workmanship. Phillips Recessed Head Screws make driving so simple, so steady that the most inexperienced operator soon becomes master of the trickiest fastening jobs!

If these are the kind of results you'd like, but aren't getting from slotted and other type screws, you owe it to yourself and to your workers to switch to Phillips – the screws with the *Scientifically Engineered Recess.* They cost *less to use* . . . because they help you *produce much more.* Any one of the 23 manufacturers below will enable you to prove it in your own plant.

TO MAKE WARTIME QUOTAS AND PEACETIME PROFITS

Faster Starting: Driver point automatically centers in the Phillips Recess . . . fits snugly. Fumbling, wobbly starts, slant driving are eliminated. Work is made trouble-proof for green hands.

Faster Driving: Spiral and power driving are made practical. Driver won't slip from recess to spoil material or injure worker. (Average time saving is 50%.)

Easier Driving: Turning power is fully utilized. Workers maintain speed without tiring.

Better Fastening: Screws are set-up uniformly tight, without burring or breaking of screw heads. The job is stronger, and the ornamental recess adds to appearance.

IDENTIFY IT!

Center corners of Phillips Recess are rounded . . . NOT square.

Bottom of Phillips Recess is nearly flat . . . NOT tapered to a sharp point.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS · MACHINE SCREWS · SELF TAPPING SCREWS · STOVE BOLTS

23 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

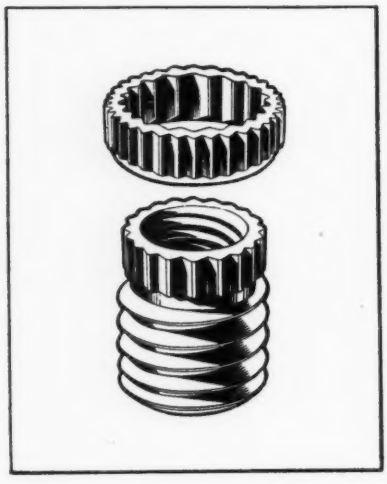
Union Carbide and Carbon Corporation, Kokomo, Ind. These round tool bits are furnished centerless-ground to tolerances of plus 0.000 and minus 0.002 inch on the diameter, and plus or minus 1/16 inch on the length. They are intended for use in turning or boring operations or they can be ground to suitable forms or shapes for use as drills or reamers.

These tool bits have the same red hardness, edge strength, toughness, and abrasion resistance as the Stellite square and rectangular tool bits. Tool bits of 98M2 Stellite are made for faster machining of steel, while tool bits of Star J-Metal are for use in machining cast iron, malleable iron, bronze, brass, aluminum, and some steels. 93

Threaded Insert with Locking Ring

Threaded inserts and studs developed to facilitate salvaging castings or parts with damaged threads have been placed on the market by Bardwell & McAlister, Inc. P. O. Box 1310, Hollywood 28, Calif. The steel inserts are locked firmly in place, but can be easily removed and replaced without disturbing the casting or part.

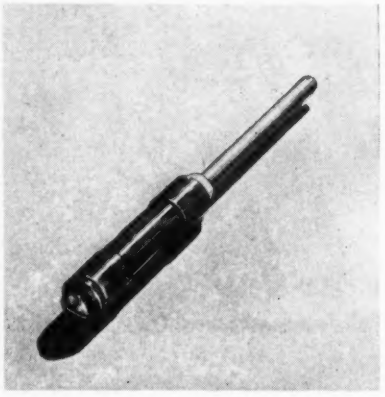
As shown in the accompanying illustration, these Rosan inserts and studs are made in two pieces, consisting of a body and a locking ring. The locking ring, which is serrated inside and out, has its inner teeth designed to mesh with the serrations of a collar on the insert or the stud, while its outer teeth broach the wall of a counterbore around this collar when the ring is pressed or driven into place. The fastening ring can be easily removed by a simple, shallow drilling operation. Standard threads are used throughout, and the units can be installed without special tools if necessary. 94



Rosan Threaded Insert with Locking Ring

Rieger Expansion Type Spindle Stop

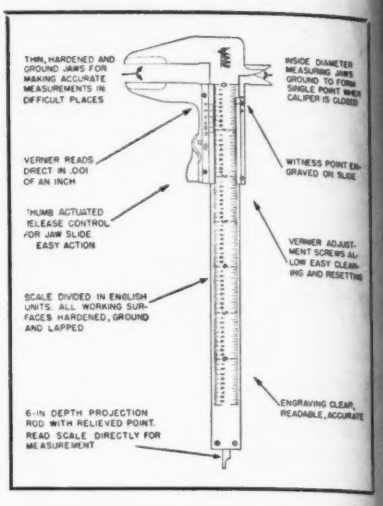
The principal feature of the new spindle stop brought out by the Rieger Mfg. Co., Department M-7, Miamisburg, Ohio, is the expanding collet action employed to secure the stop in the spindle hole. While the front end of the device is held in place with one screwdriver, a turn on another screwdriver inserted at the rear end of the spindle causes the stop to expand and tighten itself in the hole of the headstock spindle. This clamping arrangement has the advantage of avoiding any scarring or burring of the walls.



Rieger Work-locating Stop for Spindles of Small Lathes

The stop is equipped with a 5/16-by 4-inch extension for locating hollow work and short pieces. The extension is left soft, so that it can be turned down to a smaller diameter if desired. It can be removed for positioning solid pieces. The body of the device is 3 inches long and slightly under 3/4 inch in diameter when contracted.

The spindle stop is used for "repeat" operations on the lathe, and can be utilized with or without a chuck. The regular model is applicable to lathes which have 3/4-inch spindle holes. 95


THIN, HARDENED AND GROUND JAWS FOR MAKING ACCURATE MEASUREMENTS IN DIFFICULT PLACES
INSIDE DIAMETER MEASURING JAWS GROUND TO FORM SINGLE POINT WHEN CALIPER IS CLOSED
VERNIER READS DIRECT IN .001 OF AN INCH
WITNESS POINT ENGRAVED ON SLIDE
THUMB ACTUATED RELEASE CONTROL FOR JAW SLIDE EASY ACTION
VERNIER ADJUSTMENT SCREWS ALLOW EASY CLEANING AND RESETTING
SCALE DIVIDED IN ENGLISH UNITS. ALL WORKING SURFACES HARDENED, GROUND AND LAPPED
ENGRAVING CLEAR, READABLE, ACCURATE
6-IN DEPTH PROJECTION ROD WITH RELIEVED POINT. READ SCALE DIRECTLY FOR MEASUREMENT

Vernier Caliper Made by Vard Inc.

Vard Vernier Caliper

A new vernier caliper designed to facilitate quick accurate measurement of outside diameters and precision checking of inside diameters on the same vernier scale is being manufactured by Vard Inc., 2961 E. Colorado Blvd., Pasadena 8, Calif. The caliper can also be used to measure the depth of a hole by inserting the depth projection rod and reading the distance from the end of the rod to the body of the caliper on the vernier scale. The depth gage is an integral part of the tool and not an attachment.

This caliper has a measuring capacity of 6 inches between the jaws. It is constructed of precision ground steel and has hardened and lapped jaws. One edge is graduated in thirty-seconds of an inch, and the other in fortieths to read in thousandths on the vernier. The vernier is integrally mounted on the slide, and is locked in position or released by pressing a thumb-lever. 96

Chrome-Plated Rotary Files and Burrs

Carbide Specialties, Division of Park Engineering & Tool Co., 1114-18 Southfield Road, Lincoln Park 25, Mich., has recently developed and placed on the market a line of hard chromium-plated rotary files and burrs. These chromium-plated tools are offered in all standard sizes and shapes of rotary files and burring tools. Special tools or cutters can be manufactured to users'

To obtain additional information on equipment described on this page, see lower part of page 214.

MACHINERY'S DATA SHEETS 517 and 518

COMMON WELDING TROUBLES—CAUSES AND CURES. 3

Trouble	Cause	Cure
Poor Surface Appearance	(1) Improper current and arc voltage. (2) Overheated work. (3) Poor electrode manipulation. (4) Inherent characteristic of electrode used.	(A) Insure use of proper welding technique for the electrode employed. (B) Do not use excessive welding currents. (C) Use a uniform weave or rate of travel at all times. (D) Prevent overheating of work.
Poor Fusion	(1) Improper diameter of electrode. (2) Improper welding current. (3) Improper preparation of joint. (4) Improper welding speed.	(A) When welding in narrow vees, use an electrode small enough to reach the bottom. (B) Use sufficient welding current to deposit the metal and penetrate the plates. Heavier plates require higher current for a given electrode than light plates. (C) Be sure the weave is wide enough to thoroughly melt sides of joint. (D) The deposited metal should tend to sweat onto the plates and not curl away from them.
Incomplete Penetration	(1) Improper preparation of joint. (2) Use of too large an electrode. (3) Insufficient welding current. (4) Welding speed too fast.	(A) Be sure to allow the proper free space at the bottom of a weld. (B) Do not expect excessive penetration from an electrode. (C) Use small diameter electrodes in a narrow welding groove. (D) Use sufficient welding current to obtain proper penetration. Do not weld too rapidly.

MACHINERY'S Data Sheet No. 517, July, 1944

Compiled by C. H. Jennings, Welding Engineer Westinghouse Electric & Mfg. Co.

COMMON WELDING TROUBLES—CAUSES AND CURES. 4

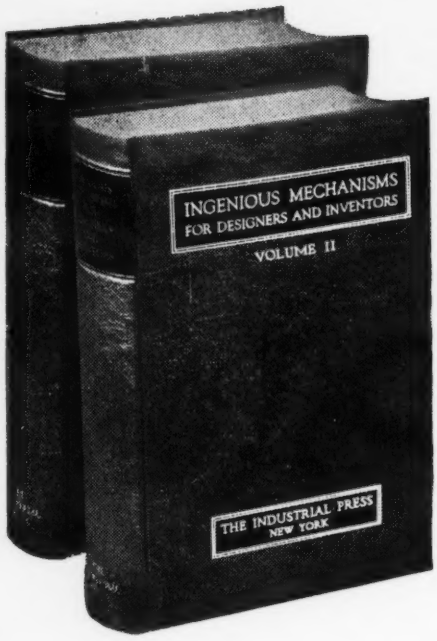
Trouble	Cause	Cure
Porous Welds	(1) Inherent property of some electrodes. (2) Not sufficient puddling time to allow entrapped gas to escape. (3) Poor base metal. (4) Too short an arc length.	(A) Some electrodes inherently produce sounder welds than others. Be sure the proper electrodes are used. (B) Puddling keeps the weld metal molten longer and often insures sounder welds. (C) A weld made of a series of strung beads is apt to contain minute pin-holes. Weaving will often eliminate this trouble. (D) Do not use excessive welding currents. (E) In some cases the base metal may be at fault. Check this for segregations and impurities. (F) Do not hold too short an arc.
Brittle Joints	(1) Air hardening base metal. (2) Improper heating. (3) Unsatisfactory electrode.	(A) When welding on medium carbon steel or certain alloy steels, the heat-affected zone may become hard as a result of rapid cooling. Preheating at 300 to 500 degrees F. should be resorted to before welding. (B) Multiple layer welds will tend to anneal hard zones. (C) Annealing at 1100 to 1200 degrees F. after welding will generally soften hard areas formed during welding. (D) The use of austenitic electrodes is sometimes more desirable on steels that harden readily. The increased weld ductility compensates for the brittle, heat-affected area in the base metal.
Irregular Weld Quality	(1) Improper electrode manipulation. (2) Excessive welding current. (3) Welding in position for which electrode is not designed. (4) Improper joint design.	(A) Use a uniform weave or rate of travel at all times. (B) Do not use excessive welding currents. (C) Use an electrode designed for the type of weld and the position in which the weld is to be made. (D) Prepare all joints properly.

MACHINERY'S Data Sheet No. 518, July, 1944

Compiled by C. H. Jennings, Welding Engineer Westinghouse Electric & Mfg. Co.

Ingenious Mechanisms

for Designers and Inventors



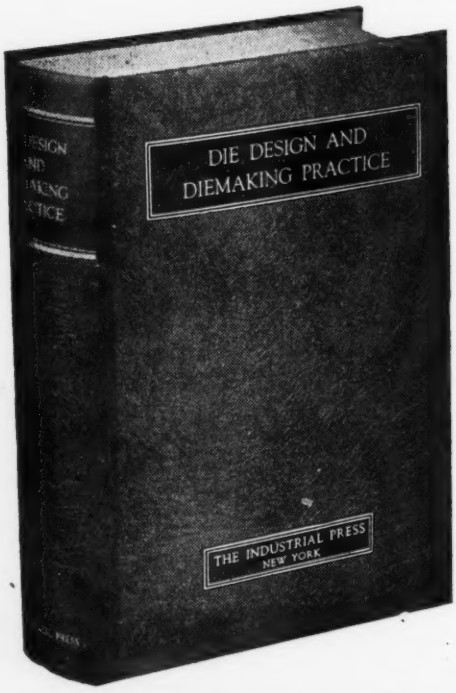
To own these two volumes, that form a complete course of study, is to have a comprehensive encyclopedia of mechanical movements unparalleled in scope and usefulness. Each volume is an entirely independent treatise on mechanisms; both books are similar in size and general character, but the contents are different.

Every mechanism described and illustrated embodies some idea or principle likely to prove useful to designers or inventors. Volume I contains 536 pages and 300 illustrations; Volume II, 538 pages and 303 illustrations. Price, $8 set or $5 for either book separately.

THE INDUSTRIAL PRESS, 148 Lafayette Street, New York 13, N. Y.

Die Design and Diemaking Practice

THE MOST COMPLETE TREATISE IN EXISTENCE ON DIES



If you design, make or use dies for blanking, forming or drawing sheet-metal parts, here is a veritable die designer's and diemaker's bible. This die book presents not only descriptions and drawings of a tremendous variety of dies, but a vast amount of data representing a lot of boiled down and costly die experience. Dies of the same general classes are grouped together in chapters. The drawing dies have been placed into chapters according to the general shapes of the parts produced, to facilitate finding the type of die for producing a given shape.

Price $6—payable if desired $2 with order and $2 monthly for two months.

956 pages, 590 illustrations

THE INDUSTRIAL PRESS, 148 Lafayette Street, New York 13, N. Y.

specifications. Worn high-speed steel rotary files can also be reconditioned and chromium-plated. Extensive tests have shown that the chromium plating increases the life of high-speed steel tools from five to ten times. 97

Radius and Angle Grinding Wheel Dresser

Radius, angle, and form dressing of grinding wheels can be accomplished with unusual accuracy and speed on a dresser recently brought out by the Best Tools Corporation, Rockville Centre, Long Island, N. Y. By the proper transposition of the various attachments on the sliding head casting of this dresser, a great many previously unobtainable shapes can be quickly and easily duplicated. The dresser can be easily disassembled for inspection or cleaning, and is designed to keep moving parts free from abrasive.

When equipped as shown in Fig. 1, it can be used for dressing the wheel to a convex or concave form of any radius from 0 up to 1 inch. Fig. 2 shows the dresser with the base opened to show the templet and tracer finger used when dressing wheels to correspond with the profile of the templet. When the dresser base is closed, the tracer finger is held against the templet by a spring-actuated plunger. As the operator turns the knurled knob to the right, the tracer finger follows the templet, causing the chisel-pointed diamond to duplicate the contour on the abrasive wheel. To check results, the templet is removed and placed against the wheel for use as a gage. 98

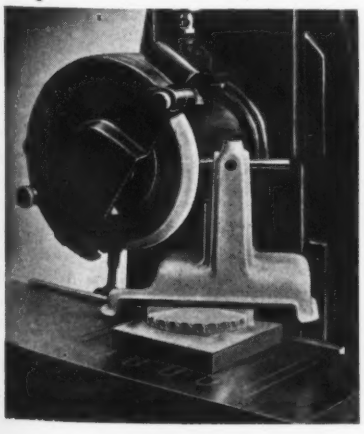


Fig. 1. Grinding Wheel Dresser Arranged for Convex or Concave Dressing Operations

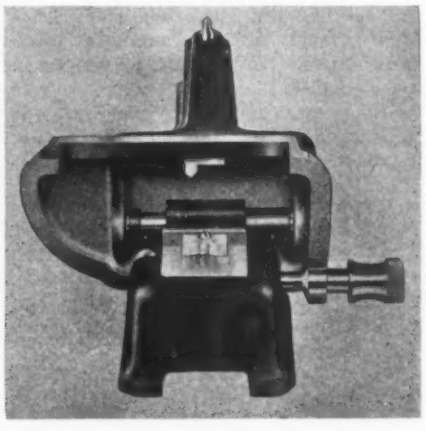


Fig. 2. Dresser Base Opened to Show Templet Used in Dressing for Profile Grinding

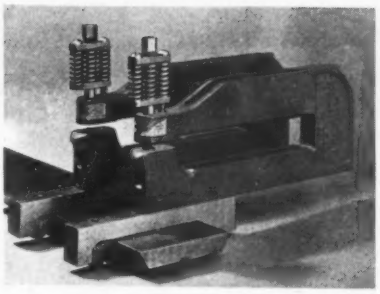


Fig. 1. Wales Type BC Hole-punching Units Mounted on a Press Brake Rail

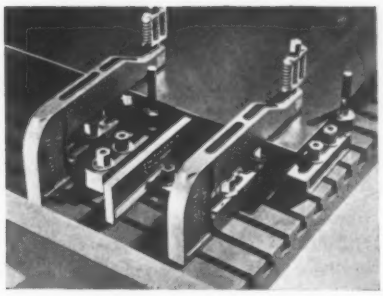


Fig. 2. Hole-punching Units Mounted on Plate with Work Stops and Feed Rail

Wales Hole-Punching Units

The Type BC units recently added to the line of equipment made by the Wales-Strippit Corporation, 345 Payne Ave., North Tonawanda, N. Y., for punching holes in flat sheet metal are designed to provide maximum stripping action and to be set up to punch any desired number of holes arranged in any pattern. They can be used on T-slotted plates and templets in stamping presses and on plates and bed rails in press brakes. They can also be used to punch an unlimited number of hole patterns with varying center distances.

The individual, self-contained units are made up of punches, dies, and stripping guide assemblies mounted in holders. The holders serve to keep the punch and die in perfect alignment. Holes of various diameters up to 5/16 inch can be punched with the same unit by simply changing the punch, die, and stripping guide assembly. Throat depths of 4, 7, and 9 inches permit a wide range of pattern set-ups. The narrow holder width permits holes to be punched as close together as 1 inch, center-to-center distance. 99

"Handl-Nib" Diamond Wheel-Dressing Tool

The Diamond Tool Co., 938 E. 41st St., Chicago 15, Ill., has developed a new double-purpose diamond dresser tool known as the "Handl-Nib," which can be used for both hand and machine dressing. This new tool consists of an ejector type handle in combination with a "Big-Hed" diamond nib, for use on a steadyrest of the grinder wheel. It is claimed that good wheel-dressing action is obtained by rolling this dresser across the face of the wheel at a slight angle.

To release the nib of this tool for use in the adapter rod of a Norton center grinder or any other machine taking a 7/16-inch shank nib, it is only necessary for the operator to hold the handle and press down on the ejector rod. When further use as a hand tool is required, the nib may be pressed by hand back into the handle socket. This tool is available with diamonds of 2 carats and larger. 100

Metallizing Gun for High-Speed Spraying

A "Metco" Type 3E metallizing gun, especially made for high-speed spraying of low melting point metals, has been brought out by the Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y. The rates of deposition of this gun per hour are said to have reached as high as 40 pounds of zinc, 70 pounds of tin, 110 pounds of lead, 90 pounds of solder, and 75 pounds of babbitt. 101

To obtain additional information on equipment described on this page, see lower part of page 214.

News of the Industry

California

CLARENCE FRAZIER, vice-president of the Food Machinery Corporation, Los Angeles, Calif., has been appointed manager of the Peerless Pump Division of that firm, succeeding the late Vernon Edler. Mr. Frazier graduated from Stamford University in 1926, having taken courses in engineering and law. He has been with the Food Machinery organization since 1941.

ECCLES & DAVIES MACHINERY CO., INC., 1910 Santa Fé Ave., Los Angeles, Calif., has been appointed southern California representative of LESTER-PHOENIX, INC., Cleveland, Ohio, to handle high-pressure die-casting machines and injection molding machines for plastic materials.

AMERICAN SCREW PRODUCTS, 7000 Avalon Blvd., Los Angeles 3, Calif., announces that the name of the company has been changed to the DEUTSCH Co. This change was found desirable because of confusion arising from the similarity of the former name with that of other companies.

MORSE TWIST DRILL & MACHINE CO., New Bedford, Mass., has opened a Pacific Coast store at 1180 Folsom St., San Francisco 3, Calif., to supplement Morse distributors' stocks and take care of emergency orders.

WALTER KIDDE & CO., Belleville, N. J., has opened a new sales and engineering office at 9507 Santa Monica Blvd., Beverly Hills, Calif., with JOHN M. NOBLE in charge as district manager.

DR. L. H. FULLER has been appointed assistant chief engineer of the Joshua Hendy Iron Works, Sunnyvale, Calif.

Illinois

A. E. LINDBERG, who has been chief engineer of the Moline Tool Co., Moline, Ill., for twenty-five years, and associated with the company for a total of thirty-four years, retired on May 1. Mr. Lindberg has not been in good health for a number of years. He expects to make his permanent residence in Los Angeles, Calif. C. E. PARKHURST, who has been connected with the company for sixteen years, has been appointed chief engineer to succeed Mr. Lindberg. D. C. EIPPER, who has been on the engineering staff for twenty-five years, has been appointed assistant chief engineer. O. R. RELLER, production manager of the company, has been elected to the position of vice-president.

CHARLES L. BLATCHFORD has been appointed secretary of the National Metal Trades Association, 122 S. Michigan Ave., Chicago, Ill. Mr. Blatchford became connected with the Chicago branch of the Association in 1922, and in 1925 succeeded his father, PAUL BLATCHFORD, as branch secretary. In 1941, he became assistant to the Commissioner of the Association, HOMER D. SAYRE.

ARTHUR S. KLOPF has been appointed manager of the Iron Division of the Firegan Sales Co., Chicago, Ill. Mr. Klopf was formerly foundry manager with the Hansell-Elcock Co., Chicago.

EARL L. HADLEY has been appointed general manager of Barnes & Reinecke, industrial designers and engineers, 664 N. Michigan Blvd., Chicago, Ill.

Michigan

LEROY CAMEL has been promoted to the position of sales manager of the Alkali Division of Detrex Corporation, Detroit 27, Mich. He was previously manager of the eastern section of the division in Cleveland. The promotion of JOEL COOPER, Detroit, and HERMAN GROSSER, Cleveland, to the position of division managers in their respective territories was also announced. THOS. J. KEARNEY, formerly technical advisor to the director of sales, has been promoted to assistant chief engineer in charge of industrial equipment design and detailing. JOHN A. FALER, assistant chief engineer, has been placed in charge of extraction equipment development.

CHARLES GROSS has been appointed sales manager of the Murchey Machine & Tool Co., Detroit, Mich. Mr. Gross was formerly with Aeronautical Products, Inc., Detroit, where he served in the capacity of assistant general sales manager. Previous to that he was general manager of the Auto Railer Division of the Evans Products Co.

HARDINGE BROTHERS, INC., Elmira, N. Y., have established an engineering and service office at 4460 Cass Ave., Detroit 1, Mich. The office will be in charge of CHARLES BOLAND, who has been with the organization in Elmira for the last eight years.

STAPLES ENGINEERING CO., 1315 S. Woodward Ave., Birmingham, Mich., has been appointed representative in the state of Michigan for the DAVIS BORING TOOL DIVISION of the LARKIN PACKER CO., St. Louis, Mo.

PROFESSOR HUGH E. KEELER, of the Mechanical Engineering Department of the University of Michigan, has been appointed a member of the American Standards Association's Committee on Code for Pressure Piping.

ERNEST E. ANDERSON, 351 Yarmouth Road, Birmingham, Mich., has resigned as works manager and director of the Goddard & Goddard Co., Detroit, Mich., with whom he has been connected for twenty-six years.

Minnesota, Iowa, and Missouri

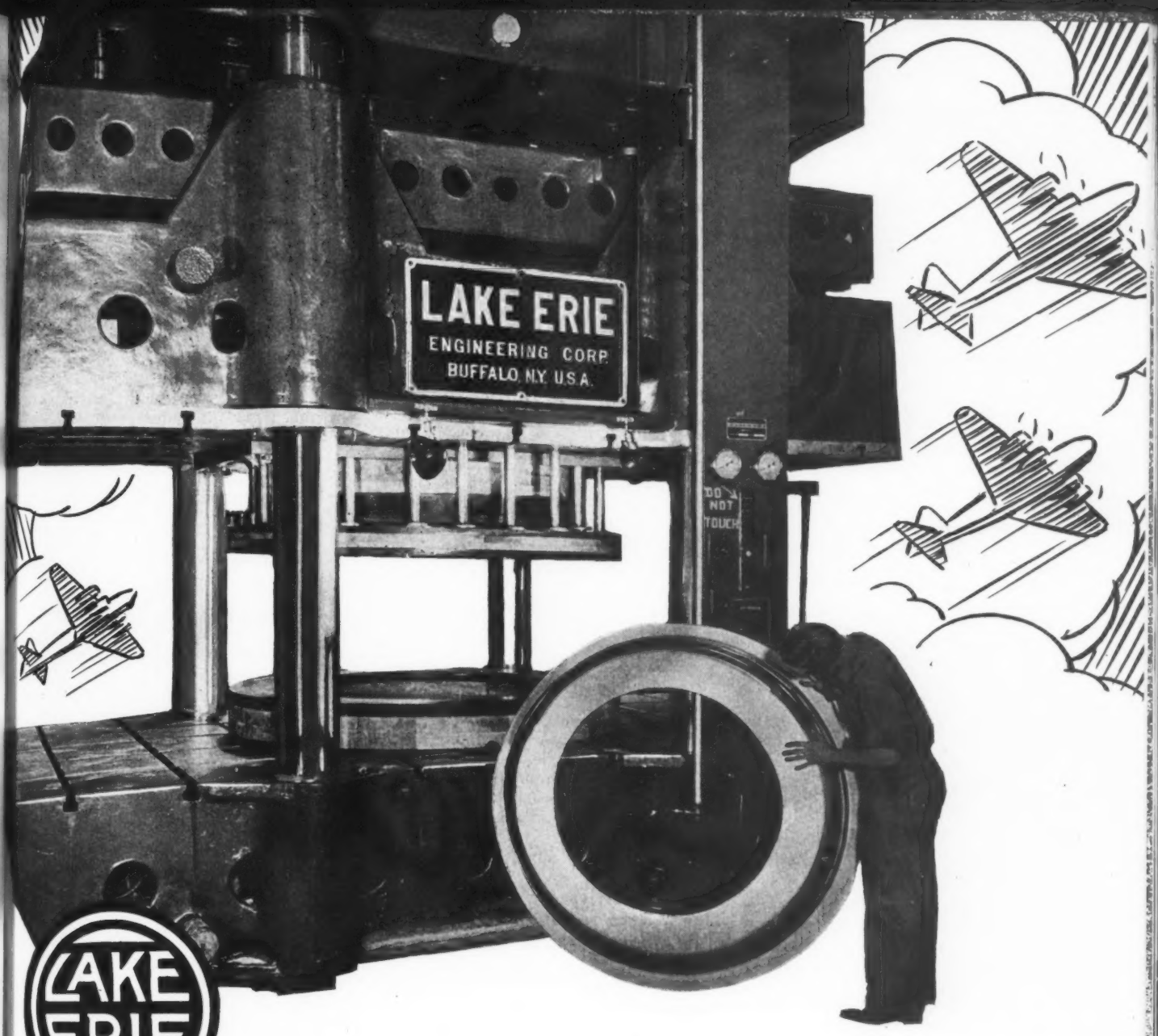
CLARENCE W. PEARSON has been appointed plant superintendent of Rodgers Hydraulic Inc., Minneapolis, Minn. Mr. Pearson was formerly connected with the Twin Cities Ordnance plant as general superintendent of the 30-caliber ammunition department.

UNIVERSAL ENGINEERING CORPORATION, Cedar Rapids, Iowa, designer and manufacturer of dies, jigs, gages, special taps and cutting tools, and special machinery, has acquired the manufacturing rights, parts, stocks, and current orders for the U-6 Automatic and Coulter types of thread milling machines, formerly manufactured by the Automatic Machinery Corporation and the Bolton Mfg. Co., both of Bridgeport, Conn. H. EARL FRIES has been appointed manager of the Machine Tool Division of the Universal Engineering Corporation.

V. H. HIERMEIER has been made industrial manager of the St. Louis office of the Brown Instrument Co., Philadelphia, Pa. Mr. Hiermeier, who succeeds I. K. FARLEY, has had fifteen years experience in the industrial instrument field.

New England

HAROLD J. RITTER has resigned his position as vice-president and director of the Norma-Hoffmann Bearings Corporation, Stamford, Conn., after an association of twenty-eight years with the concern. Mr. Ritter began his career as secretary to the founder of the company, the late W. M. Nones, and has served in various capacities since that time. He was made assistant secretary of the company in 1928, secretary in 1936, and vice-president in 1939. He has been a director since 1936 and has also occupied the post of sales manager since 1932. Mr. Ritter's future plans have not yet been announced.



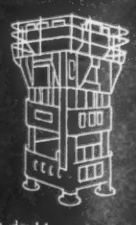
LAKE ERIE

Whether your problem is to economically produce a variety of parts in limited quantities or continuous production at increased speeds with extreme accuracy, do it better with LAKE ERIE presses.

LAKE ERIE HYDRAULIC PRESSES have universal adaptability for every operation from deep drawing of large parts to shallow forming of small pieces using rubber pads with rapid changeover of dies. LAKE ERIE HYDRAULIC PRESSES should be investigated by the men who do the planning for your company's future.

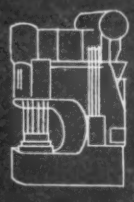
LAKE ERIE ENGINEERING CORP., BUFFALO 17, NEW YORK

District representatives: 250 Park Avenue, New York 17, N. Y.; 230 North Michigan Avenue, Chicago 1, Illinois; Harron, Rickard and McCone, San Francisco and Los Angeles, California; Buck & Hickman, London, England.

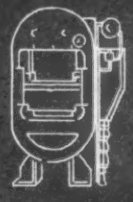


gle, double and triple action
wing and forming presses.

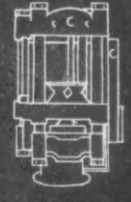
Accurate pressing control
straightening presses.



Specially designed shipbuild-
ing and plate bending presses.



Solid housing presses for
heavy-pressure operations.



Presses for compression
molded plastic products.

CLEVELAND AUTOMATIC MACHINE CO. has opened a new district office at Capitol National Bank Bldg., Hartford 1, Conn., Room 529, under the managership of W. O. ALDRICH, who has been serving as special representative with headquarters in the Cleveland office. The Hartford district will assume responsibility for part of the territory formerly handled by the Newark office. R. T. CARROLL has been appointed district manager at the Newark office. Mr. Carroll has been connected with selling and servicing automatic equipment for more than fifteen years.

WILSON MECHANICAL INSTRUMENT CO., INC., 383 Concord Ave., New York 54, N. Y., sole maker of the Rockwell hardness tester, was recently acquired by the AMERICAN CHAIN & CABLE CO., INC., Bridgeport, Conn. CHARLES H. WILSON will continue to be actively associated with the company.

FRANK W. BEMIS has been appointed sales manager of the American Cable and Hazard Wire Rope Divisions of the American Chain & Cable Co., Inc., Bridgeport, Conn. Mr. Bemis has been with the company since 1938.

ROBERT L. COE, vice-president of the Chase Brass & Copper Co., Inc., Waterbury, Conn., was re-elected president of the Copper and Brass Research Association at the recent annual meeting of the Association.

AMERICAN SCREW CO., Providence, R. I., announces the election of the following officers: CHARLES O. DRAYTON, formerly general sales manager, has been elected vice-president in charge of sales. GEORGE H. REAMA, formerly factory manager, has been elected vice-president in charge of manufacturing of the company.

CLIFFORD D. APPLETON, who has been vice-president of the LEON J. BARRETT CO. for the last seven years, has been appointed manager of the Machine Division of the Rolled Thread Die Co., Worcester, Mass.

New Jersey

WILLIAM F. BURDITT, SR., has been elected president of the Service Machine Co., 158 Miller St., Elizabeth, N. J., engineers and manufacturers of dies, fixtures, and machined parts. PAUL DOXEY, formerly works manager of the Turbo Engineering Co., Trenton, N. J., has been made works manager of the company, and ERNEST CARLSON, previously chief of machine design of the Allen Engineering Co., has been made chief process engineer. ARTHUR K. BURDITT, former president, has resigned to devote himself to the operation of his own business.

INDUSTRIAL HARD CHROMIUM PLATING EQUIPMENT CORPORATION, 13 Rome St., Newark, N. J., has been formed to manufacture plating equipment. WILLIAM A. CROWDER is president of the new organization. Since 1937, Mr. Crowder has been president and sole owner of the Industrial Hard Chromium Co. of Newark, N. J.

New York

UNION CARBIDE AND CARBON CORPORATION, 30 E. 42nd St., New York City, announces the election of the following presidents of subsidiary companies: JAMES W. MCLAUGHLIN has been elected president of the Bakelite Corporation. STANLEY B. KIRK is the new president of The Linde Air Products Co., The Prest-O-Lite Co., Inc., Dominion Oxygen Co., Ltd., and Prest-O-Lite Co. of Canada, Ltd. ARTHUR V. WILKER becomes president of the National Carbon Co., Inc., and the Canadian National Carbon Co., Ltd. FRANCIS P. GORMELY has been elected president of the Electro Metallurgical Co., the Electro Metallurgical Co. of Canada, Ltd., Haynes Stellite Co., Michigan Northern Power Co., and Union Carbide Co. of Canada, Ltd. DR. JOSEPH G. DAVIDSON is president of Carbide and Carbon Chemicals Corporation and Carbide and Carbon Chemicals, Ltd.

GEORGE KELLER MACHINERY CO., Buffalo, N. Y., has been appointed exclusive distributor for western New York State of thread-rolling dies and cylindrical-die thread rollers made by the Rolled Thread Die Co., Worcester, Mass. C. H. BRIGGS MACHINE TOOL CO., INC., Syracuse, N. Y., has been appointed distributor for central New York and northern Pennsylvania.

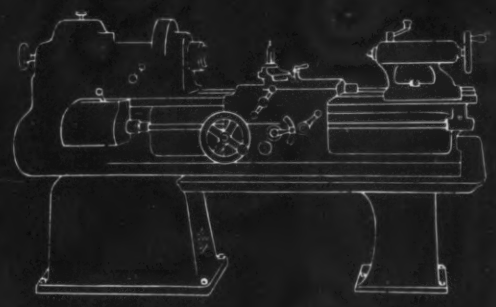
CLINTON E. SWIFT has been appointed assistant manager of the engineering and research department of the Eutectic Welding Alloys Co., 40 Worth St., New York 13, N. Y. Before joining the company, Mr. Swift was manager of the Welding Division of Ampco Metal, Inc. In his new position, Mr. Swift will handle industrial welding problems.

GEORGE H. COMPTER has been appointed staff engineer in the Aeronautics Division of the Society of Automotive Engineers, 29 W. 39th St., New York City. Mr. Compter was until recently manager of the Inspection Salvage Department of the Brewster Aeronautical Corporation. He is a graduate of the University of Michigan.

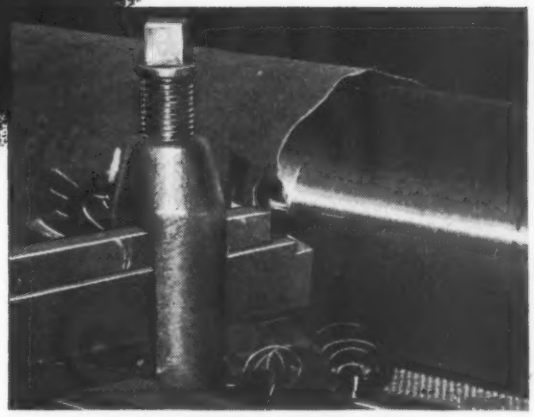
(Left to Right) James W. McLaughlin, Stanley B. Kirk, and Francis P. Gormely, Recently Elected Presidents of Subsidiaries of the Union Carbide and Carbon Corporation

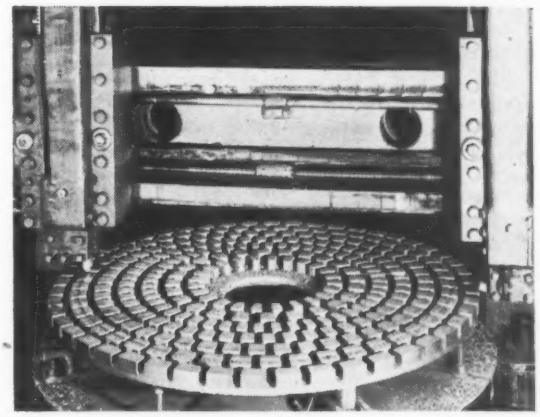
The m

a



COST





Cost—in the over-all terms of man-hours, materials, and machines invested—is the most important factor in either wartime or peacetime production. War goods produced economically help save the lives of our fighting men, hasten the successful conclusion of hostilities, counteract inflation, will ease the transition from war to peace. Peacetime goods produced economically help more people enjoy the benefits of better things at less cost.

Are you effecting machining economies? If you use Kennametal-tipped tools, the answer is—***Yes***. Kennametal is the unique cemented carbide composition—discovered, developed, and produced in America. Kennametal-tipped tools cut and mill metals 2 to 6 times faster—remove 10 to 50 times the metal before the tool must be resharpened—last up to 20 times as long as former tools—produce a smooth, accurate finish that reduces grinding and polishing operations—in many cases eliminate expensive and time-consuming annealing operations by machining steel in the hardened state. Their use multiplies the capacity of available equipment—means utmost productivity per man, per machine, per unit of power consumed.

Kennametal-tipped tools are available for lathe, boring mill, and milling machine operations on steels up to 550 Brinell, cast-iron, and non-ferrous materials. Switch to Kennametal today to cut metals—and most important, to cut costs.

KENNAMETAL

SUPERIOR CEMENTED CARBIDES

KENNAMETAL *Inc.*, LATROBE, PA.

CARBORUNDUM Co., Niagara Falls, N. Y., has opened three new branch sales offices—one at Buffalo, N. Y., with G. S. ROGERS in charge; one at St. Louis, Mo., with GORDON O. WATSON in charge; and one at San Francisco, Calif., with W. T. MCCARGO in charge.

ALPHA METAL & ROLLING MILLS, INC., 363 Hudson Ave., Brooklyn 1, N. Y., announce that the name of the firm has been changed to ALPHA METALS, INC.

FOUNTAIN DIE CUTTING Co. has moved to a new location at 533 Canal St., New York 13, N. Y.

Ohio

CHARLES E. SORENSEN, for many years executive vice-president and general manager with the Ford Motor Co., has become chief executive officer of Willys-Overland Motors, Inc., Toledo, Ohio, and will later become president of this company. Mr. Sorensen was born in Copenhagen, Denmark. He became associated with Henry Ford in 1905 as a patternmaker, and rapidly rose to the important position that he held with the Ford organization for many years.

HILL ACME Co., Cleveland 15, Ohio, has appointed the JOHN E. LIVINGSTONE Co., Detroit, Mich., exclusive agent for the line of Acme forging machines, threading machines, and tapping machines. The MOORE MACHINERY Co., San Francisco, Calif., has been appointed exclusive sales representative in the northern half of California and the state of Nevada for the sale of Hill open-side vertical- and horizontal-spindle hydraulic surface grinders.

WILLIAM F. LAMOREAUX has been appointed research metallurgist of the Cooper-Bessemer Corporation, Mount Vernon, Ohio, and Grove City, Pa. For the last three years, Mr. Lamoreaux has been director of research for the Meehanite Metal Corporation.

GEORGE H. CLARK, vice-president in charge of engineering of the Formica Insulation Co., Cincinnati, Ohio, has been elected a director of the Society of the Plastics Industry at its spring meeting in Chicago.

FRANK J. BROGAN has been appointed special sales representative in Texas, Oklahoma, Arkansas, and Louisiana for the BUNTING BRASS & BRONZE Co., Toledo, Ohio. He will make his headquarters in Dallas, Tex.

CARL ESCHEDOR has been appointed factory employment manager for Willys-Overland Motors, Inc., Toledo, Ohio, to fill the vacancy created by the death of William Moore.

C. B. POOLER has been appointed vice-president in charge of manufacturing of the Philip Carey Mfg. Co., Cincinnati, Ohio.

Oregon

G. L. REVELL has been appointed district manager of the Portland, Ore., office of the Lincoln Electric Co., Cleveland, Ohio, manufacturer of arc-welding equipment, succeeding E. H. WEIL, who is now a lieutenant in the Navy. Mr. Revell has been connected with the company for eight years, and was formerly a welding engineer in the Los Angeles and San Francisco offices. J. W. DONNELLY, also a welding engineer, has been transferred to the Portland office. Both Mr. Revell and Mr. Donnelly are acting as welding consultants for the U. S. Maritime Commission in the Portland area.

Pennsylvania

FRANK K. METZGER has been elected vice-president in charge of sales of the Baldwin Locomotive Works, Philadelphia, Pa. Mr. Metzger has been associated with the Baldwin organization since 1909, when he was employed by the Standard Steel Works Co., a Baldwin subsidiary. With this company he became successively sales manager, vice-president in charge of sales, and, in 1930, vice-president and general manager in charge of operations and sales. When the Standard Steel Works Co. became a division of the Baldwin Locomotive Works, he was elected divisional vice-president of the Baldwin Locomotive Works, in charge of the Standard Steel Works Division. JOHN D. TYSON has been elected divisional vice-president in charge of the Standard Steel Works Division. Mr. Tyson has been with the Standard Steel Works organization since 1923 as assistant metallurgical engineer, chief metallurgist, and manager of sales and metallurgy.

Frank K. Metzger, Vice-president in Charge of Sales of the Baldwin Locomotive Works

WALTER P. SCHMITTER was presented with the Edward P. Connell Award by the American Gear Manufacturers Association at its annual meeting on May 23. The award was established by the Falk Corporation as a memorial to the late Edward P. Connell, vice-president, and is presented by the American Gear Manufacturers Association in recognition of valuable contributions to the gear industry, to the art of gear design and manufacture, or to the American Gear Manufacturers Association. Mr. Schmitter is a past-president of the Association.

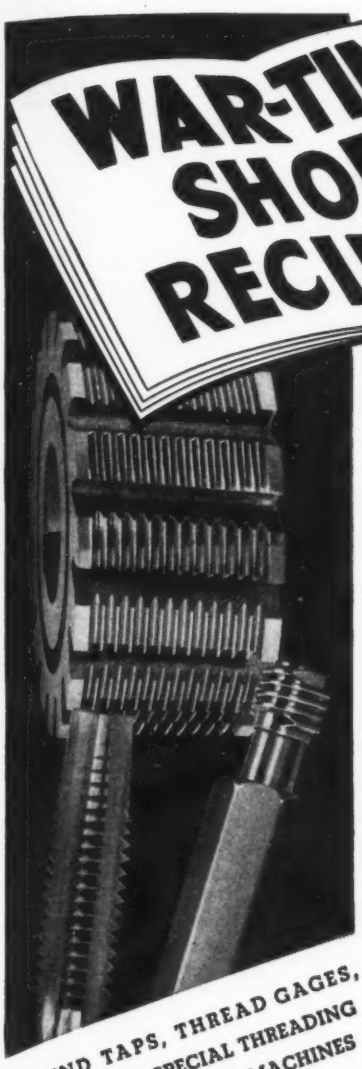
Walter P. Schmitter, Recipient of the Edward P. Connell Award Presented by AGMA

EDGAR C. THOMAS, who was recently honorably discharged from the United States Army with the rank of major, has been elected vice-president of the Thomas Machine Mfg. Co., Pittsburgh, Pa. Mr. Thomas has spent his entire industrial career in the company founded by his father, George P. Thomas. Prior to the war, he had charge of the company's Chicago office and later of its Philadelphia office. A member of the U. S. Army Reserve Corps since 1923, he served in the war as battalion commander, anti-aircraft artillery, until he returned to the company. As vice-president, he will direct sales with particular emphasis on foreign markets.

H. L. ROBINSON has been appointed manager of the new Pittsburgh plant of Joseph T. Ryerson & Son, Inc. Mr. Robinson started with the Ryerson organization in 1923 in the plant engi-

WAR-TIME SHOP RECIPES

Now Available



GROUND TAPS, THREAD GAGES, THREAD HOBS & SPECIAL THREADING TOOLS. SPECIAL TAPPING MACHINES

THREAD MILLING CUTTER
A pocket Manual for sharpening THREAD MILLING CUTTERS
and sharpening hints
DETROIT
TAP & TOOL CO.
8432 BUTLER . . DETROIT 11 U.S.A.

Includes:

1. Sharpening Instructions
2. Conversion tables (Rake angles & hook)
3. How to compute offset distances
4. Factors affecting thread accuracy

Ask for Manual No. HT-43

BUY U.S. BONDS STAMPS

DETROIT TAP & TOOL CO.

8432 BUTLER
DETROIT 11,
MICH., U.S.A.

neering department, later being transferred to the machinery division, and then to the general sales department. In 1929, he went from Chicago to join the sales staff of the Cleveland plant.

JOHN M. MCKIBBIN has been appointed assistant to the vice-president of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in charge of product and industry advertising. He was formerly manager of the company's application data and training department.

G. CLYMER BROOKE has been appointed assistant to the president of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. Mr. Brooke has been associated with the company since 1931, and was made assistant secretary in 1941.

M. D. BENSLEY has been appointed general manager of three plants of the H. K. Porter Co., Inc., Pittsburgh, Pa. The three plants, located at Mt. Vernon, Ill., recently became subsidiaries of the Porter organization.

WILLIAM CHRISTOPHER ROBINSON, president of the National Electric Products Corporation, has been elected a member of the board of directors of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

R. C. BRANNAN has been appointed manager of the Transformer Equipments Section of the Transformer Division of the Westinghouse Electric & Mfg. Co., Sharon, Pa.

* * *

New Service for Locating Screw Machine Capacity

Owing to the many requests for assistance in locating available automatic screw machine capacity, the National Screw Machine Products Association, 13210 Shaker Square, Cleveland 20, Ohio, has set up a clearing house for such requests. In this way, it is possible to promptly locate manufacturers best equipped to produce any particular type of screw machine parts. The service is provided free to buyers of screw machine products.

* * *

Financial Report to Employes

The Allegheny Ludlum Steel Corporation, Pittsburgh, Pa., has inaugurated a program of keeping employes informed on company operations. A financial report is issued to the 12,500 employes of the company. The report is written in easily understandable language and illustrated with graphic charts that are simple and concise.

Obituaries

ALBERT H. ARMSTRONG, widely known for his work in railroad electrification until he retired from the General Electric Co., Schenectady, N. Y., in 1930, died on May 31 in Schenectady after a long illness. He was seventy-three years old. Mr. Armstrong was born in Worcester, Mass., and graduated from the Worcester Polytechnic Institute in 1891. Immediately upon graduation, he entered the employ of the Thomson-Houston Electric Co., Lynn, Mass. When this company was merged to form the General Electric Co. in 1892, he went to Schenectady to work under the direction of the late Dr. Charles P. Steinmetz. Subsequently, he joined the Railway Engineering Department of the company, and from that time on devoted most of his time to the study of railway problems.

WILLIAM H. KNIGHT, one of the early pioneers with the Buick Motor Car Co., died recently at his home in Flint, Mich., at the age of eighty-five years. Mr. Knight became connected with the Buick organization in 1908 as superintendent of the division where transmissions and automobile chassis were manufactured. Later he was appointed manager of the Tooling Division which contributed largely to the successful production of the Liberty aircraft engines in the last World War. He retired from the organization twelve years ago.

Mr. Knight was born in Halifax, Nova Scotia. In his early twenties, he came to the United States and was first connected with the Pratt & Whitney Co., of Hartford, Conn.

LOUIS MANSFIELD ROSSI, vice-president of the Bakelite Corporation, Unit of Union Carbide and Carbon Corporation, died on May 25 at the Medical Center, New York City, following a sudden illness. He was sixty-six years old. Mr. Rossi had been connected with the Bakelite organization since 1910, when he became works manager of the General Bakelite Co., then formed; in 1919, he was made general manager. In 1923, after the consolidation of several companies into the Bakelite Corporation, Mr. Rossi was elected vice-president and director of manufacturing, which position he retained until his death.

FREDERICK J. WILLITS, purchasing agent of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., died on May 27 at the Waterbury Hospital after an illness of two weeks. Mr. Willits was born in England in 1884, but had lived in Waterbury for fifty-seven years, and was associated with the Waterbury Farrel organization for forty-six years. He became purchasing agent in 1927.

Coming Events

SEPTEMBER 21-23—Annual meeting of the NATIONAL TOOL AND DIE MANUFACTURERS ASSOCIATION at the Hotel Statler, Buffalo, N. Y. M. W. Rowell, general manager, Southern Bldg., 15th and H Sts., Washington, D. C.

OCTOBER 2-5—Fall meeting of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS at the Netherland-Plaza Hotel, Cincinnati, Ohio. Clarence E. Davies, secretary, 29 W. 39th St., New York 18, N. Y.

OCTOBER 5-7 — Aircraft Engineering and Production Meeting of the SOCIETY OF AUTOMOTIVE ENGINEERS at the Hotel Biltmore, Los Angeles, Calif. John A. C. Warner, secretary and general manager, 29 W. 39th St., New York City.

OCTOBER 12-14—Semi-annual meeting of the AMERICAN SOCIETY OF TOOL ENGINEERS at Syracuse, N. Y. Adrian L. Potter, executive secretary, 2567 W. Grand Blvd., Detroit 8, Mich.

OCTOBER 16-20—Twenty-sixth annual meeting of the AMERICAN SOCIETY FOR METALS AND THE NATIONAL METAL CONGRESS, to be held at the Public Auditorium, Cleveland, Ohio. W. H. Eisenman, secretary, American Society for Metals, 7301 Euclid Ave., Cleveland.

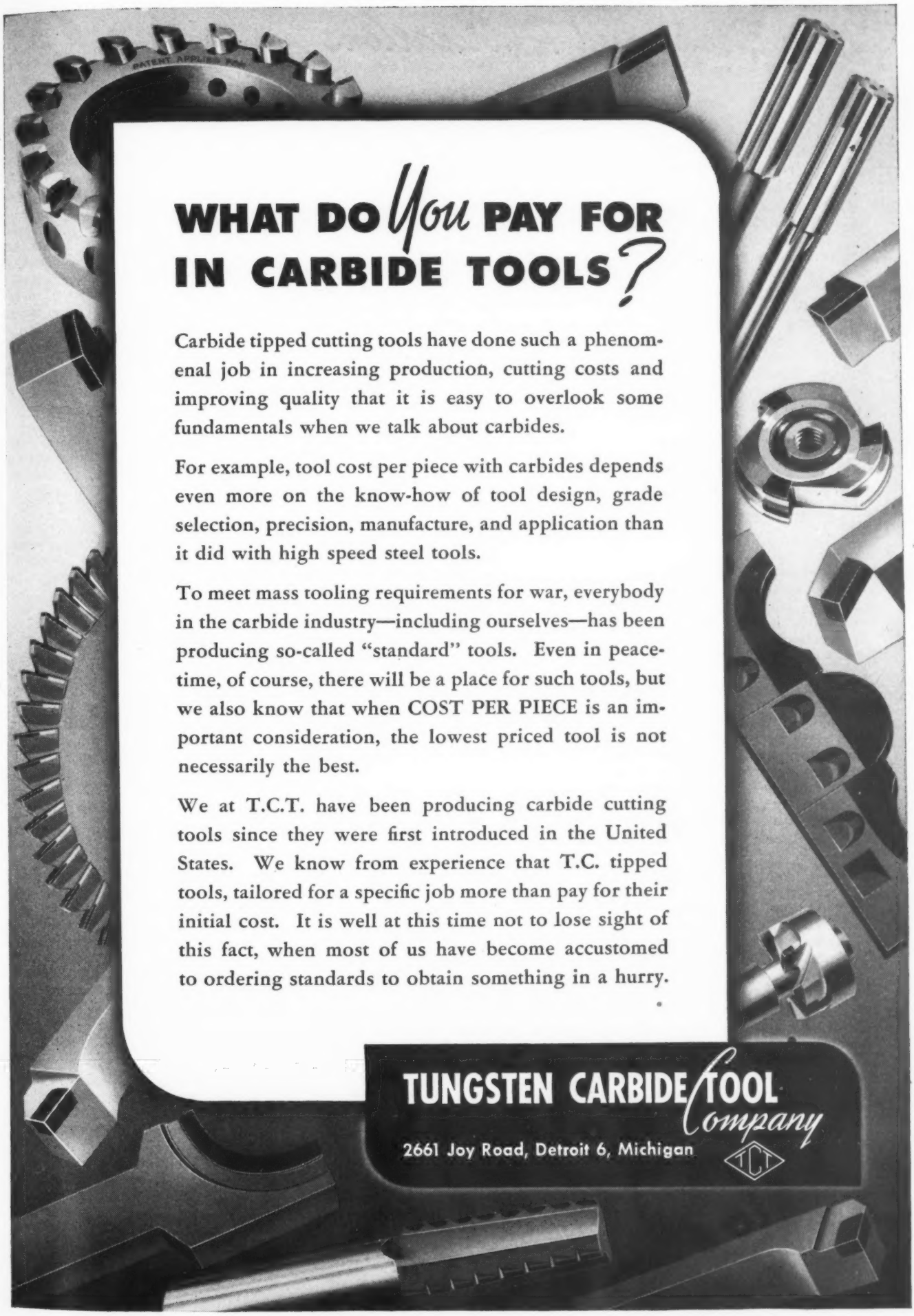
OCTOBER 30 - NOVEMBER 1—Twenty-seventh semi-annual meeting of the AMERICAN GEAR MANUFACTURERS ASSOCIATION at the Edgewater Beach Hotel, Chicago, Ill. Newbold C. Goin, executive secretary, Empire Bldg., Pittsburgh 22, Pa.

NOVEMBER 2-3—Eighth annual NATIONAL TIME AND MOTION STUDY CLINIC at the Medinah Club, Chicago, Ill., under the auspices of the Industrial Management Society. Further information can be obtained from the vice-president of the Society, C. S. Becker, 205 W. Wacker Drive, Chicago 6, Ill.

NOVEMBER 15-19 — THIRD NATIONAL CHEMICAL EXPOSITION in the Chicago Coliseum, Chicago, Ill. M. H. Arveson, chairman Exposition Committee, American Chemical Society, 330 S. Wells St., Chicago 6, Ill.

NOVEMBER 27-DECEMBER 1—Annual meeting of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS at Hotel Pennsylvania, New York City. Clarence E. Davies, secretary, 29 W. 39th St., New York 18, N. Y.

JANUARY 8-12, 1945—Annual meeting of the SOCIETY OF AUTOMOTIVE ENGINEERS at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, secretary and general manager, 29 W. 39th St., New York City.



WHAT DO *You* PAY FOR IN CARBIDE TOOLS?

Carbide tipped cutting tools have done such a phenomenal job in increasing production, cutting costs and improving quality that it is easy to overlook some fundamentals when we talk about carbides.

For example, tool cost per piece with carbides depends even more on the know-how of tool design, grade selection, precision, manufacture, and application than it did with high speed steel tools.

To meet mass tooling requirements for war, everybody in the carbide industry—including ourselves—has been producing so-called "standard" tools. Even in peacetime, of course, there will be a place for such tools, but we also know that when COST PER PIECE is an important consideration, the lowest priced tool is not necessarily the best.

We at T.C.T. have been producing carbide cutting tools since they were first introduced in the United States. We know from experience that T.C. tipped tools, tailored for a specific job more than pay for their initial cost. It is well at this time not to lose sight of this fact, when most of us have become accustomed to ordering standards to obtain something in a hurry.

TUNGSTEN CARBIDE TOOL *Company*

2661 Joy Road, Detroit 6, Michigan

TCT

New Books and Publications

BROACHES AND BROACHING. 97 pages, 8 by 11 inches; 149 illustrations. Published under the auspices of the Broaching Tool Institute, 74 Trinity Place, New York 6, N. Y. Price, $3.

The purpose of this volume, which has been brought out by the Broaching Tool Institute, a nation-wide organization of broaching tool manufacturers, is to bring to American industry a comprehensive discussion of broaching practice, to call attention to the very rapid recent progress in the broaching field, and to emphasize the application of broaching to both war and post-war production. The Broaching Tool Institute is in an exceptional position to sponsor such a volume, since the purpose of the Institute is to compile standards, encourage research, and foster the progress of broaching for the benefit of industry at large. The basic data which forms the basis of this book was chiefly contributed by the engineering staffs of the broach manufacturers who are members of the Institute. The principles outlined and the examples and practical applications cited are taken from the first-hand experience of highly qualified engineers.

A concise idea of the contents of the book may be obtained from a listing of the chapter headings: History of Broaching; Advantages, Applications, Limitations of Broaching; Types of Broaches; Broach Cutting Action; Material to be Broached; Broach Design; Information Needed for Design and Manufacturing of Broaches; Broach Cost Factors; Handling Broaches; Sharpening Broaches; Broaching Machines; Setting up Broaching Machine; Fixtures; and Cutting Fluids.

PRACTICAL ANALYTIC GEOMETRY WITH APPLICATIONS TO AIRCRAFT. By Roy A. Liming. 330 pages, 5 1/2 by 8 1/2 inches. Published by the Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price, $4.50.

The object of this text-book is two-fold—to answer the need for a practical system of analytic calculation techniques for direct use in the aircraft, automotive, and marine industries; and to provide the student of mathematics, particularly of analytic geometry, with the motivation that comes with seeing his subject alive and creative in industrial fields. The main body of the text is divided into three parts. Part I deals with applied plane analytic geometry; Part II embraces applied solid analytic geometry; and Part III develops and applies a system of analytic analysis to curves commonly required in the lofting of streamline bodies.

CONVEYORS AND RELATED EQUIPMENT. By Wilbur G. Hudson. 341 pages, 5 1/2 by 8 1/2 inches. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Price, $5.

This book has been written in order to present information regarding the kind of conveying equipment that can be used to best advantage. It covers the applications and limitations of the various types of materials-handling equipment, methods of storage, layouts, proper erection, performance, maintenance, and comparative costs. As the subject of materials-handling is too broad to be covered comprehensively in one volume, this book is confined to a discussion of the equipment most commonly used.

AIRCRAFT PRODUCTION ILLUSTRATION. By George Tharratt. 201 pages, 8 1/2 by 11 inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $3.50.

This book comprises a text and reference manual for students in perspective lay-out, technical sketching, and the basic principles of production illustration as applied in the aircraft field. The author gives an account of the history of production illustration and its potentialities in the reorganization and operation of fast moving production lines. The book also contains suggestions for the introduction of this method into existing engineering and manufacturing organizations.

NEOPRENE. 45 pages, 6 by 9 inches. Published by the United States Department of Labor, Washington, D. C. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 10 cents per copy.

This booklet deals with the hazards involved in manufacturing, processing, and fabricating the synthetic rubber known as "Neoprene," and gives suggestions for safeguarding workers handling this material. The book is the first of a series to be issued, the present pamphlet dealing especially with ventilation control of possible toxic vapors.

PICTORIAL GUIDE TO MACHINE SHOP PRACTICE. By H. Grisbrook and C. Phillipson. 91 pages, 5 3/8 by 7 3/4 inches. Published by Emerson Books, Inc., 251 West 19th St., New York City. Price, $1.50.

The basic principles of machine shop practice are set forth in this book by a series of drawings illustrating the right and the wrong way of performing an operation. Captions provide the necessary instructions, and there are notes on general work-shop procedure; the handling of machine tools; lubrication; calculation of cutting speed; milling; and cutting compounds.

ESSENTIALS OF PRECISION INSPECTION. By Wesley Mollard. 207 pages, 8 1/2 by 11 inches. Published by the McGraw-Hill Book Co., 330 W. 42nd St., New York City. Price, $3.

This book is a work manual containing detailed instruction in the use of various measuring instruments, as well as technical information on checking the location of holes, threads, gears, etc., and the procedures to be followed in checking a piece of work to specifications. The material is intended to lay the foundation for the development of skill in using and applying precision tools and instruments. The text is supplemented by problems with outlined procedures to follow.

GUIDE TO WELDABILITY OF STEELS. 89 pages, 6 by 9 inches. Published by the American Welding Society, 33 W. 39th St., New York 18, N. Y. Price, $1.

This booklet outlines a proposed system of determining the effect of welding procedure upon the ductility of the heated zone adjacent to the weld in plain carbon and alloy steels, based upon extensive investigations of the War Metallurgy Committee and the Welding Research Council.

THE SUPERVISOR'S JOB IN INDUSTRY. By Anthony C. Baudek and Mark L. Brooks. 128 pages, 4 1/2 by 6 inches. Published by McKnight & McKnight, Bloomington, Ill. Price, 80 cents, paper-bound.

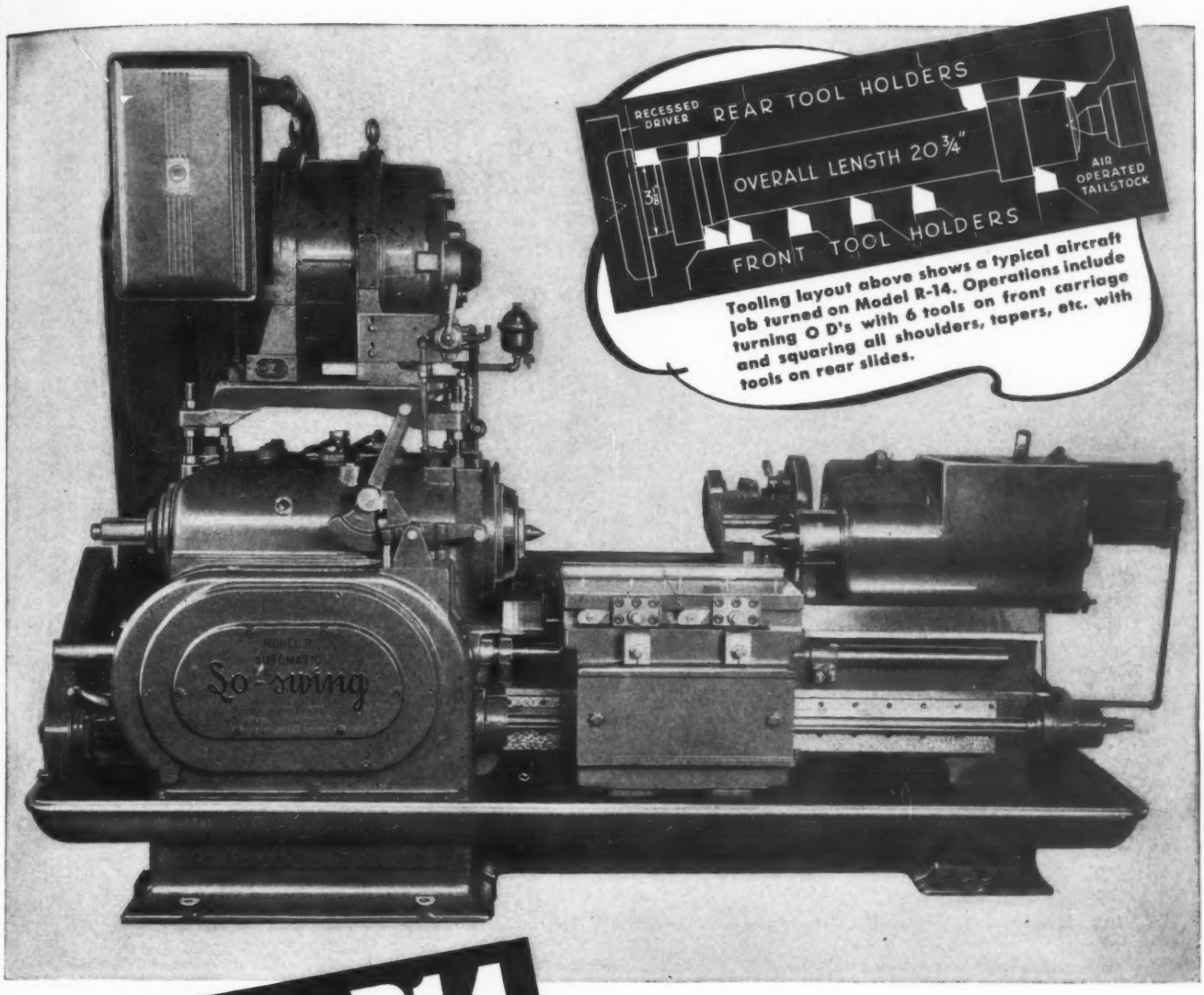
* * *

Machine Gas-Cutting Guide

A pocket-size, slide type guide that shows the proper tip sizes, gas pressures, and other data required for machine gas-cutting of steel of various thicknesses with two widely used machine gas-cutting tips known, respectively, as "Airco 45" and "Airco 124," has been brought out by, and is available upon request to, Air Reduction, 60 E. 42nd St., New York 17, N. Y.

* * *

During the war, the aluminum manufacturing capacity of the United States has been increased seven times, and that of magnesium approximately one hundred times. Before the war, our annual aluminum capacity was from 300,000,000 to 350,000,000 pounds. Now, it amounts to considerably over 2,000,000,000 pounds. The magnesium capacity before the war was 6,000,000 pounds. It is now about 600,000,000 pounds.


RECESSED DRIVER
REAR TOOL HOLDERS
OVERALL LENGTH 20¾"
3/8"
AIR OPERATED TAILSTOCK
FRONT TOOL HOLDERS
Tooling layout above shows a typical aircraft job turned on Model R-14. Operations include turning O D's with 6 tools on front carriage and squaring all shoulders, tapers, etc. with tools on rear slides.
Lo-swing

MODEL Lo-swing R14

MAKING HISTORY ON AIRCRAFT PRODUCTION

● **THIS BIG, powerful automatic lathe has set many records for low "per-piece" cost on aircraft motor cylinders, landing struts, tank, tractor and truck parts and other heavy war work. It incorporates the Seneca Falls Simplified Change-over Mechanism making it a practical machine for either short run or volume production. Length of carriage stroke and rapid traverse adjustment may be varied without changing any cams.**

Positive operation, wide flexibility and servicing simplicity are important advantages of this design. Model R-14 may be equipped with a third arm (overhead) as well as additional back squaring attachments, carriages, carriage slides and work handling devices.

Write for condensed Catalog No. 42 showing the various types of Lo-swing production-boosting lathes.

SENECA FALLS MACHINE CO., SENECA FALLS, N. Y.

LATHE NEWS from SENECA FALLS

Classified Contents of This Number

Airplane Production

Plastic Punches Facilitate Lockheed Metal-Forming—*By George H. Prudden* 136

Boeing Technique in Stretch-Forming Rolled and Extruded Shapes—*By Boyd K. Bucey* 146

Rubber Sheeting Speeds up Martin Stretching Operations—*By Harry F. Vollmer* 156

Milling Douglas Integral-Eye Spar Caps from Rolled Billets—*By N. A. Lombard and G. R. Gwynne* 164

Hot-Forming Magnesium Plates at Northrop—*By Paul Hawley and Robert L. Gunter* 176

Thermo-Elastic Forming Airplane Parts from Phenolic Plastics—*By W. I. Beach* 182

Consolidated-Vultee Bucking-Bar Development Expedites Production Riveting—*By E. P. Myers* .. 188

Expediting Curtiss-Wright Heat-Treating, Anodizing, and Plating—*By E. K. Fry* 192

Management Problems

Steady Employment is Created through Capital Investment 200

New Service for Locating Screw Machine Capacity 256

Financial Reports to Employes 256

Materials, Metals, and Alloys

Specifying Steel by Performance—*By Greswold Van Dyke* 206

Stop-Off Paint for Use in Selective Carburizing .. 210

New Group of Air-Drying Electrical Insulating Varnishes 210

Combination of Plastics and Glass Provides New Structural Material 210

New Design Resilient Mounting for Instruments, Couplings, Etc. 210

Formex Ribbon Magnet Wire Available as Thin as 0.004 Inch 210

Meetings and News of Societies

American Gear Manufacturers Association Elects Officers 205

News of Industry

Engineering News 199

Machine Tool Requirements for 1944 207

Machine Tool Demand Increasing 211

News of the Industry 250

Shop Practice

Grinding to Ten-Thousandths Inch on a High-Production Basis—*By Ralph Price* 201

How to Secure Fine Surfaces by Grinding—*By the Late H. J Wills and H. J. Ingram* 208

Development of Art of Chromium-Plating Cutting Tools 211

Shop Equipment News 215

Machine Gas-Cutting Guide 258

Training, Industrial

Unique Course in Impact Die-Forging 205

Your Progress Depends Upon Your Knowledge of Your Industry